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COMMUNICATIONS

A DEVICE FOR THE ACCURATE LOCALIZATION OF HOLES IN RETINAL DETACHMENTS

BY

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LONDON

THERE is no divergence of view as to the need of localizing accurately the hole or holes in a retinal detachment as a preliminary to the cautery puncture operation, and a number of means have been put forward to this end. The present device is not intended to be used in the place of such calculations, but as an adjunct to them. It consists of a gold stud which is inserted through the sclera at the spot which has been calculated, by whatever means, to correspond with the position of the retinal hole. The end of the stud is then identified by means of the ophthalmoscope, and the exact relationship of the retinal hole to it is seen, and the actual site for the cautery puncture is adjusted in the light of the information so obtained. The studs are made of gold, with a flat circular or oval base, and a stem of varying length; a small hole is made in the base, through which silk is threaded, otherwise the stud is likely to be lost. I have had some made with circular and some with oval bases; the idea of the latter was to indicate readily the position of the flattening of the apex of the stem, as explained later; this can also be indicated by the position of the hole in the base. I believe the circular base is the better. The base is 5 mm. across if circular, and 6 by 4 mm. if oval. The stem is of four lengths, 2, 4, 6, and 8 mm.; it is circular in section at its upper

part, and tapers slightly towards its attachment to the base of the stud, with the idea that when it is *in situ* the grip of the tissues on the slightly conical stem will tend to keep the base pressed home against the sclerotic. (Figs. 1 and 2.) The free end is flattened so as to be oval in section, rounded off, very smooth, and highly polished, all with a view of facilitating its insertion through a small linear incision and to prevent its doing damage to the retina when this membrane is pushed before it; it is exactly 1 mm. in width. (Figs. 1 and 2). Forceps, with a ribbed face and without a

FIG. 1.

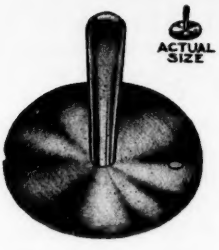

FIG. 2.

catch, forms a convenient means for holding the stud by its base when inserting it.

Method of Use.—The point for the cautery puncture through the sclera is calculated and marked by whatever method the surgeon is in the habit of using. The studs are sterilized by boiling and, if it is evident that the retinal hole is well away from the choroid, a stud with a long stem is used; if, however, the detachment is a shallow one, one with a 2 or 4 mm. stem is chosen. An incision with a narrow bent needle, with a stop, is now made at the calculated spot, of such a size as will just admit the stem of the stud: the blade of the one I use is of 2mm. width and 2·5 mm. long, with a stop, and is made by Messrs. J. Weiss & Son. Before making the incision, and after sterilizing, the upper surface only of the blade is painted with an alcoholic solution of gentian violet and allowed to become quite dry; the object is to stain the edge of the cut so that the small incision is easily found again when the needle is withdrawn. At first I dipped the blade in the solution so that both its upper and under surfaces were covered by the stain; in this case, however, when the under surface came into contact with the soft tissues, as is inevitable, they became stained and so the distinctness of the small puncture was obscured. If, however, the upper surface alone is covered with stain, the soft tissues do not come into contact with it and a fine linear staining of the anterior edge of the incision in the sclerotic results, without confusing colouring of surrounding parts. The chosen stud is now inserted through the incision with a slight rocking movement, and is pushed right home; it is essential that its base should be flat against the sclera. The tissues which have been reflected to expose the sclerotic are now pulled into place, and the inside of the eye is examined with the ophthalmoscope: in order that the transparency of the cornea may be in nowise impaired, little cocaine should be used, and a receptacle containing warm normal saline and a small pipette should be kept at hand, for keeping the cornea moist throughout the operation. I have had no difficulty in identifying the position of the apex of the stud and its relationship to the hole or holes; no haemorrhage has occurred to obscure the view.

Examination may now reveal that the stud clearly is too far back, or not sufficiently far back, or that it is to one or other side of the hole, and the allowance to ensure that the hole of puncture shall exactly correspond with the retinal hole is then calculated; the knowledge that the breadth of the end of the stud is 1 mm. in width assists the calculation. Having thus determined the exact relationship of the true puncture point to the point of insertion of the stud, the soft tissues are again turned back so as to expose the sclera; everything is had in readiness, the stud removed, and the

puncture immediately proceeded with. When the stud is removed there is a small escape of vitreous, but it is inconsiderable in amount. It will be obvious that the small incision for the insertion of the stud will by no means always be included in the area of subsequent cautery puncture. Care must be taken that the base of the stud lies flat upon the sclera, else the stem will take an oblique direction and its summit will not correspond with the point of its entry through the sclerotic. At first I had a small keel attached to the outer side of the base as a means of gripping the stud for its introduction, but I found that this provided a point of leverage for the tissues, which pushed it sideways and so caused a deflection of the stem from the vertical to the sclerotic. With a view of rendering the apex conspicuous in contrast with the rest of the stem when seen with the ophthalmoscope it might be advantageous to have its tip silver-plated. It will be obvious that the object of this device is to locate the position of a hole with precision, and consequently it is of greater value in the case of retinal holes than in the case of oral tears, though I have found it valuable also in the latter. It is assumed that when the cautery puncture is made, the line along which the retinal hole falls back to come into contact with the outer coats, is a perpendicular to the sclerotic.

Before using the studs I had tried a sharp needle, with an appropriate curve, and a stop to prevent it from entering too far, made for me by Messrs. J. Weiss & Son; but apart from the difficulty of ophthalmoscope examination with the needle *in situ*, I found that it had the serious disadvantage that it was liable to make a fresh hole in the retina, whereas if the stud does not engage in the retinal hole it can be seen to push the retina before it somewhat like a tent pole, owing to its smooth rounded end, and if the right length of stud is chosen it does not lacerate this membrane.

I have especially to thank my friend Mr. Wilton Thew, for putting his skilful dental mechanic, Mr. W. D. Rogers, at my disposal; he has made and modified the experimental studs for me and has taken great care over them. They are now manufactured and supplied in sets of four by Messrs. Theodore Hamblin Ltd., of 15 Wigmore Street.

CONTACT GLASSES

BY

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HISTORICAL.

THE possibility of correcting anomalies of refraction by means of lenses in actual contact with the eye seems to have occurred to several investigators during the past century or so. It is known that the younger Herschel, astronomer and physicist, attempted to make contact glasses about 1827. I have not been able to get exact details of his experiments, but apparently he adopted a method of casting from a gelatine negative and used the glass positive moulded therein along with a gelatine meniscus in contact with the cornea. In 1887 Dr. A. E. Fick* advocated contact glasses for keratoconus. His experiments were mostly concerned with blown glasses but it is on record that he approached Abbé with a view to having examples ground. Whether Abbé attempted to grind any is unknown, but he had specimens blown for him in the Forest of Thuringia. About the same date Kalts in Paris experimented with contact glasses but did not publish. Later, a few practical opticians actually ground some specimens—Strübin in Basle and Himmler in Berlin. In 1892 Sulzer had contact glasses ground for him by opticians in Paris and Geneva. Müller, of Wiesbaden, whose glasses will be referred to in more detail later, was associated with the experiments of Fick in 1887 and has produced blown glasses ever since. The firm of Carl Zeiss, of Jena, first produced ground contact glasses for experimental purposes in 1911 and for keratoconus in 1918.

So far, in spite of repeated attempts and isolated successes, there is little progress to record. The history is that of many other scientific conceptions; the idea had to await fulfilment until progress in other branches of science had sufficiently advanced to translate it into practice. The equipment of the optical manufacturer was manifestly unequal to the task. Before such technical excellence as that of the present Zeiss model became more than a mere possibility a whole series of new machines and processes had to be devised. The technique of grinding out of a single piece of glass a small, fragile bowl, complicated in form, mathematically exact in curvature, and polished so finely as to be tolerated by the eye, is obviously one of great precision and delicacy. The shape ultimately chosen is a difficult one to work to, being a section of

*I am happy to say that Dr. Fick is still alive. He now lives in retirement near Munich.

a double sphere, the respective radii of which are usually unequal. At the junction of the two spherical surfaces there is a projecting inner rim which, like the outer edge, must be carefully rounded off and polished. The curvatures of both surfaces must be optically exact and the thickness of the optical area uniform and accurate. The material, moreover, is very thin and very hard, qualities which add to the difficulty of working. The manner in which these difficult problems were finally solved by the firm of Zeiss should prove, when fully known, to be one of the romances of optical history.

During the past few years this firm has greatly extended the possibilities of this method of correction and now manufacture contact glasses and trial sets designed to cover practically the whole range of ametropia.* This remarkable result is in great measure due to one man, Geheimrat Prof. Leopold Heine, of Kiel University, whose energy, enthusiasm, and experiments, ably seconded by those of the scientific staff of Messrs. Zeiss, have placed the use of contact glasses in its present satisfactory position.

DESCRIPTION OF ZEISS GROUND GLASSES.

The Zeiss ground contact glass (Fig. 1) is a thin, transparent, hollowed bowl which fits on to the anterior part of the eyeball beneath the lids, in contact with the sclera but separated from the

FIG. 1.

Zeiss Ground Contact Glasses.

cornea by a fluid meniscus. It consists of a central, optically effective crown, which forms an arc of a sphere, surrounded by an optically ineffective peripheral brim, which is also spherical. The former may be called the corneal portion; the latter the sclerotic. The material is crown glass which has in sodium light a refractive

*Within the past month or two Messrs. Zeiss have succeeded in manufacturing contact glasses with a scleral radius which is less than the corneal radius.

index $\mu = 1{\cdot}516$, and is chemically highly resistant in order to withstand the corroding action of tears.

The central or corneal part has a diameter of approximately 12 mm. and is about 0·5 mm. thick at the vertex. The diameter of the sclerotic zone (*i.e.*, of the whole glass) is about 20 mm. and the thickness of the edge about 0·3 mm. The total weight of a contact glass is only 0·5 gm. (grs. 7). It is thus easily carried by the eyeball in its movements around the centre of rotation.

For the examination of patients Messrs. Zeiss now supply two trial sets of test contact glasses, a larger and a smaller. In both sets the glasses are arranged in three series according to three standard scleral measurements. Each series has the same range of corneal radii—viz. from 5 to 11 mm.—representing the radius of curvature of the inner surface. In the smaller set the unit of corneal radius is 1 mm., *i.e.*, it contains test glasses corresponding to the whole numbers 5 to 11. The unit in the larger set is the half-millimetre, so that this set contains additional glasses corresponding to 5·5, 6·5, and so on up to 11 mm. of corneal radius. Professor Heine recommends still further sub-division, *i.e.*, a set with corneal radii progressing by 0·25 mm. The radii of the inner scleral curvatures in both sets usually measure 11, 12, and 13 mm. respectively, but half-millimetre sub-divisions are also available. These figures are etched on the rim of each glass in the trial case. The vertex thickness of each glass is also given though not indicated on the glass itself. Tinted glasses with a light absorption value of 25 per cent., 50 per cent. and 75 per cent. to protect the eye from glare can be added to the trial case, the tint being incorporated in the corneal portion.

Two important points should be noted. First, the radius of the inner surface of the corneal portion is taken as the standard. That of the outer surface may have to be modified by having a plus or minus sphere worked on it. This point will be apparent later when the details of prescribing are considered. Secondly, the trial test glass and often the actual glass made for the patient is afocal, that is, the corneal crown has no optical power in air. The dominant factor in the combination (afocal contact glass + fluid meniscus + ametropic ocular system) is the fluid meniscus lying between the cornea and the inner surface of the contact glass.

MÜLLER'S BLOWN CONTACT GLASSES

The firm of Messrs. F. Ad. Müller Söhne, of Wiesbaden, directed by Dr. F. Müller, Sen., has manufactured blown contact glasses continuously since 1887. At least two other German firms make similar glasses at the present time. Müller's glasses were first designed for protective purposes, to prevent injury to the

cornea in cases of inadequate closure of the lids, absence of eyelids, dystichiasis or entropion, etc., but it soon became apparent that they were also able to correct defects of corneal refraction. The type of refractive defect for which blown glasses have been and are being used includes chiefly conditions such as leucomata, the result either of injury or disease, and conical cornea. They can be used equally well, however, for myopia or aphakia.

There are perhaps no finer examples of the glass-blower's art than these glasses. If we acknowledge the ground contact glass to be a triumph of mechanical achievement, we must equally admit the blown glass to be a triumph of human skill. The molten glass is endowed with the necessary form and curvature by blowing alone and undergoes no further manipulation to give it optical effectivity. That is to say, the size of the lens, its thickness, and

Fig. 2.

Müller's Blown Contact Glasses.

the radii of curvature of the outer and inner surfaces—both being important to the final result—are determined solely by the technique of the glass-blower. Few craftsmen even of the highest grade possess the necessary qualities of co-ordination, patience and skill. The delicate touch and judgment required make great and exhausting demands on the nervous energy of the workman. The act of successful blowing entails an exquisite co-ordination of hands, lips and eye—a combination of qualities essential to success but sufficiently rare to explain the somewhat restricted use to which blown glasses have hitherto been put.

In appearance Müller's blown contact glasses (Fig. 2) rather resemble artificial eyes of the " shell " type. They consist of a central, transparent, corneal portion and a surrounding opaque scleral brim. The latter is oval shaped, milky coloured and marked with representations of conjunctival vessels in order to make it inconspicuous. Its lower portion, which fits into the inferior fornix, is broader than the upper and right and left contact glasses are different.

The method of insertion is much the same as that of an artificial eye. The glass is moistened with plain water or, preferably, physiological salt solution. The patient is directed to look down. The surgeon then draws up and fixes the upper lid with his thumb, passes the upper brim of the glass under the eyelid, taking care not to abrade the cornea, and finally asks the patient to look up. At this point the lower eyelid is drawn down, the glass pressed into position over the cornea and the lower lid allowed to spring back into position over the glass. A finger can now be placed on the glass and the latter coaxed into the correct position by a light twisting movement. If the shape is correct the glass will work into position by itself, and it is well to give it a little time to do so before beginning the subjective tests. It is not necessary to instil an anaesthetic.

There is no fluid meniscus between the cornea and a blown contact glass, but there must be no air bubble between the two. Apparently, in satisfactory cases there is close contact between glass and cornea at any rate for a considerable area of the latter. The patient, however, should experience no sensation of pressure either on the cornea or conjunctiva and does not when the curvatures of the glass correspond exactly with those of the cornea and sclera. When pressure is felt on the cornea the glass is too flat. When there is conjunctival irritation the radius of curvature of the whole glass is too small. If the glass tends to change its position it is too flat and wide. If only the edge of the scleral brim appears in contact its radius of curvature is too short.

When there is conical cornea of both eyes it is better to get one eye thoroughly accustomed to the contact glass before fitting the other. At first the glass should be worn only for a few hours daily and the period gradually increased. It is taken out at night but when worn for protective purposes—lagophthalmos, spastic entropion, etc., it may be worn throughout the night so long as it is efficiently cleansed morning and evening. When not worn at night it must be cleaned, dried, and kept dry until morning.

To remove the glass the makers supply a short rod curved into a blunt hook at one end. The patient looks up, pushes the hook beneath the lower edge, looks down and by a slight movement of the rod drops the glass on to a towel.

The making of these glasses is purely empirical and, although it is possible to obtain a non-astigmatic optical zone corresponding to the natural cornea, their refractive power and correcting capacity cannot be definitely determined beforehand. This determination is made by means of tests after the glasses are finished. For this reason it is found inexpedient to manufacture a series of trial glasses for the use of surgeons, so that the personal attendance of the patient is necessary during the time the glasses are

being made. Only in this way can individual differences be taken into account, but this is a fact which undoubtedly restricts their usefulness.

Blown glasses can often be worn for years before the surface becomes roughened and with proper attention the transparency of the corneal portion can be depended upon for at least a year.

FITTING AND PRESCRIBING GROUND GLASSES

After examining the eyes in the ordinary way and determining the amount and character of the refraction, the process of selecting the best contact glass is begun. As several may have to be fitted and removed at each consultation, the conjunctiva must be anaesthetized. Holocaine (2 per cent.) is preferable to cocaine as it does not dilate the pupil. I have, however, sometimes used 2 per cent. cocaine. If more than one examination is necessary it will generally be found that a local anaesthetic need not be used except on the first occasion.

I am not sure that the most suitable solution for the fluid meniscus has yet been determined. The refractive index of the cornea is approximately $\mu = 1{\cdot}376$ and that of tears approximately $\mu = 1{\cdot}336$. Ringer's solution or normal saline (0·9 per cent.) is almost isotonic with tears, and my present practice is to use a 2 per cent. saline solution which at the time of examination is diluted with equal parts of hot water. This gives a warm solution approximately 1 per cent. in strength. Some patients find, however, that after 3-4 hours' wear this solution becomes turbid. Ridley has recently pointed out that tears have a relatively high protein content, and it is possible that the addition of a certain percentage of serum would be an improvement. I have tried this on some occasions but have not been able to satisfy myself that there was any advantage over the simpler solution.

The glass may be inserted as follows:—A small rubber sucker is applied to the convex surface to pick up the glass, which is then held vertically by the attached bulb and filled quite full with saline. The patient leans forwards until his face is almost horizontal, and while he is in this posture the surgeon controls the eyelids with the fingers of his left hand and directs the patient to look at the glass. The contact glass containing saline must be kept level and gradually apposed to the cornea. The lower rim is first inserted into the inferior fornix and as the fluid touches the cornea both lids are swept over the glass by the left hand and the suction bulb removed. It is not always easy to control an involuntary movement of the lids or of the head. Every ophthalmic surgeon is familiar with the type of patient

known as a "squeezer," and it is squeezing rather than blinking that causes trouble. The following two precautions help—the fluid should be warm and the approach to the cornea gradual and gentle. When a movement of either kind occurs part of the fluid gets spilt and a bubble of air appears between the cornea and the glass. This necessitates the glass being removed, refilled, and reinserted. With practice, however, this accident should become comparatively infrequent. Once the important matter of the correct scleral fit has been decided there will rarely be difficulty with the bubble. Its presence usually means that the glass is too flat.

In a recent communication Mr. Affleck Greeves has described an alternative method; "the surgeon stands behind or beside the patient, who may either lie on a couch with his head on a low pillow, or may sit in a chair which supports the head with a head-rest . . . . the patient is told to look slightly upwards and inwards, and the empty contact glass, held by means of the sucker in the surgeon's right hand, is inserted into the lower fornix, the surgeon depressing the lower lid slightly for that purpose with his left thumb. With his left hand the surgeon now steadies the patient's upper lid in order to prevent blinking, and while he holds the contact glass close to the globe, but not quite against it, with his right hand, an assistant allows saline to drip from an undine into the space between the contact glass and the globe. The space becomes quickly filled (the fluid remaining in it by capillary attraction), and when this is accomplished the surgeon gently applies the contact glass to the globe, at the same time allowing the upper lid to fall over the upper margin of the glass. Removal of the sucker concludes the operation."

During the examination the patient should be encouraged to insert the glass himself. It is surprising how quickly he learns to do so. I may add that after a little practice it is not difficult for either surgeon or patient to insert a contact glass without a sucker. The glass is removed by means of the sucker. The latter is pressed firmly on the centre of the cornea until it adheres. The patient moves the eye towards the nose and at the same time sweeps the glass towards the outer canthus, or *vice versa*. The surgeon as a rule can easily remove it by dislocating it from its position by means of manoeuvres of the lids.

Two separate and distinct determinations have to be made during the examination and of these the first is by far the more important:—(1) the exact fit of the scleral brim; (2) the refractive power. It will be seen in the section dealing with the optical theory of correction that the refractive power is a comparatively simple determination. Very great care, however, must be taken to ensure the accuracy of the scleral fit. It is probably fair to say

that the prescribing of contact glasses is not so much an optical problem as an orthopaedic one. Good vision depends entirely on corneal curvature, but comfort depends on scleral curvature, and in the last analysis it is comfort that determines whether a glass shall or shall not be worn. Every effort must be made to get the scleral fit as exact as possible and no glass should be prescribed until all doubt on this point is removed. The procedure is simple. The surgeon selects one of the three standard types of scleral measurement and, having placed the glass in position, makes a careful examination by the aid of a good light and condensing lens. An accurate fit is indicated by a complete zone of adhesion near the limbus. If contact is greater at the edge than at the limbus the rim will rub, irritate, and become intolerable. Examination by means of the slit-lamp and corneal microscope should be made in doubtful cases, but as a rule with good focal illumination and a loupe the correct scleral fit can be determined. It may happen that none of the three standard scleral curves fits the particular eye. For example, a 12 mm. glass may be too tight and a 13 mm. too wide. In such a case a 12·5 mm. radius will probably answer and should be prescribed.

Having settled the matter of scleral fitting the second problem, correction of the ametropia, remains to be considered. It is more convenient to discuss this in the section dealing with optical theory, but the general principle is to find the contact glass which gives the best distance vision and then add plus or minus spheres in a trial frame to see whether the vision can be still further improved. With a contact glass there is no corneal astigmatism. The effect of the fluid meniscus between the cornea and the glass is that the cornea as an optical entity disappears. Except in later life, when senile changes occur in the lens, astigmatism in otherwise normal eyes is practically always corneal.

Where spherical additions are necessary it is important to ascertain another measurement, the distance between the vertex of the contact glass *in situ* and the back of the sphere in the trial frame. This can be estimated with the Wessely keratometer. The following is a simpler method. The sphere is removed from the trial frame and a pin-hole diaphragm is substituted at exactly the same distance and accurately centred to the vertex of the contact glass. The measuring instrument* (Fig. 3) consists of a stainless steel ruler graduated along one side in millimetres, on the other in half-millimetres. A slot is cut in the scale to take a sleeve through which slides a fine metal rod. The rod can be made to project beyond the end of the rule and its other end is bifurcated

*This instrument can also be used for taking measurements for Gonin's operation for retinal detachment. It is made by Messrs. Weiss & Son, Ltd., 287, Oxford Street, W.

to form two pointers, one of which registers millimetres, the other half-millimetres. To take the measurement; the end of the ruler is placed against the diaphragm and the rod pushed through the pin-hole until it touches the contact glass. The degree of projection, recorded by the pointers, is read off the scale after the manner of a depth gauge. The accuracy of the method is not so great if plano-convex and plano-concave spheres are not available. This completes the data necessary for writing the prescription. They are:—(1) the scleral radius; (2) the corneal radius; (3) the amount (in dioptres) and sign of any additional correction; and (4) the distance in millimetres between the posterior spherical vertex and the contact glass vertex. With regard to (3) it is said that additional spheres ought not to be higher in power than about 4 D., otherwise the contact glass would become too heavy. It is often

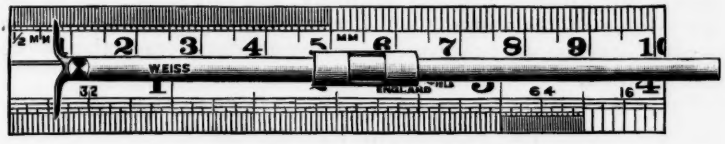

FIG. 3.

advisable, however, for reasons which are discussed later, to employ much higher spherical additions. The increase in weight does not appear to cause much inconvenience.

After the prescription has been dispensed the patient attends again in order to practice putting in the glass and taking it out under the surgeon's supervision. He is advised to wear the glasses for a few hours only at first, gradually lengthening the period until he can wear them all day without discomfort. They must always be removed at night.

The presbyope will require either a separate pair of contact glasses for close work or a pair of spectacles embodying his presbyopic addition to be worn in conjunction with his contact glasses for distance. The latter is much more convenient.

OPTICAL THEORY.

In contrasting contact glass correction of ametropia with ordinary spectacle correction the optical problems that call for consideration are very numerous. In order to avoid the somewhat unprofitable discussion of purely theoretical aspects, it seems best to select for consideration a single relevant problem and study that under both conditions. Among the phenomena that occur

when an optical instrument is associated with the eye, that of size of retinal image and the factors which influence its variation are points of practical interest.

A factor of importance in this connection is that of displacement, by measures of optical correction, of the cardinal points of the eye. If it can be shown that contact glass correction of the several varieties of ametropia involves a minimum displacement of cardinal points, in other words, a minimum departure from the optical conditions of the normal eye, then its superiority, from the purely optical point of view, over other methods of correction, *i.e.*, spectacle correction, may be regarded as established.

In this discussion I propose to accept the values and attempt to follow the methods advocated by the late Prof. Gullstrand, although I am aware that neither one nor the other has received full acceptance in this country or America. Mr. A. S. Percival, who is our greatest English authority, has criticized both in the last edition of his admirable " Prescribing of Spectacles." The general conclusions, however, remain unaffected irrespective of the method used.

THE SIZE OF THE RETINAL IMAGE.

The apparent size of an object is measured by the visual angle which it subtends at the eye. Variations in the size of this angle and consequently of the retinal image, give rise, among other effects, to certain disturbances of monocular appreciation of perspective which are of practical importance. The point in the eye at which the visual angle is measured must be defined. It may be referred, for example, to the first principal point or to the first nodal point, but in discussing perspective it is customary to refer it to the centre of rotation of the eye, since through this point in the moving eye all the principal rays necessarily pass.

The diagrams (Fig. 4) show this angle in eyes corrected by plus and minus lenses. In the case of a myopic eye the angle W formed by the principal ray with the optic axis in the object space is larger than the angle W' in the image space, whereas in hypermetropic eyes with lens correction W is smaller than W'. A myope, therefore, sees with his correction objects subtending an angle W' at the centre of rotation which is smaller than the corresponding angle W in the same space. A hypermetrope, on the other hand, sees them subtending an angle W' which is larger than the object angle W. In order to view an object subtending a certain angle the myopic eye has to rotate less and the hypermetropic eye more than the emmetropic eye. These facts have an important bearing upon the interpretation of space relations. Objects present themselves to the myopic eye so as to

subtend a comparatively small angle with a similar result as if perspective representations are viewed from too great a distance. In the case of hypermetropic eyes the effect is similar to that produced when a perspective representation is viewed at a lesser distance. Supposing the object be a cube, the fact that the near and far faces are known to be of equal height will give an

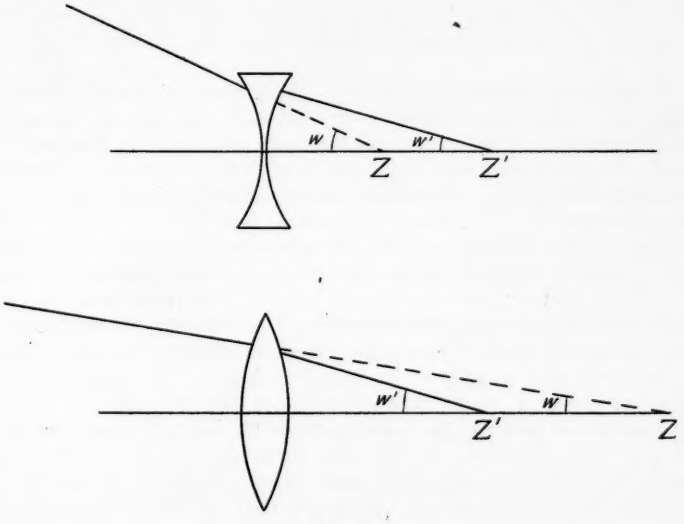

FIG 4.

impression of excessive depth to a myopic eye while a hypermetrope will underestimate it.

In spite of the fact that myopes nearly always maintain that glasses cause them to see objects reduced in size, the corrected myopic eye actually receives a somewhat larger image on the retina than a normal eye does. The size of the distinct image is related to the size of the image in the emmetropic eye in the inverse ratio of the refractive powers, *i.e.*, in the case of a myope corrected by − 10·0 D. as 58·63 : 56·44.*

It will be shown later that correction by contact glasses is not associated with these defects and that its superiority is particularly manifest in such cases as anisometropia, especially unilateral aphakia, where binocular vision would require differing amounts

* The value 56·44 of the total refraction is a consequence of assuming the position of the principal point of the correcting lens (−10·0 D) to be 12 mm. in front of the corneal vertex.

of deviation for the two eyes. It hardly seems necessary to assert that, although the ordinary user of spectacles soon becomes accustomed to disturbances such as those just described, there are occasions when a swift and accurate judgment of distance is of grave moment and even a slight miscalculation may be fraught with serious consequences. Driving a car at high speed or landing an aeroplane are examples.

THE CARDINAL POINTS.

From the standpoint of geometrical optics the eye is a system of spherical refracting surfaces of different indices of refraction centred more or less accurately upon an optic axis. To trace the path of a given incident ray through such a system and to find the position and size of the image of an object produced by paraxial rays incident upon it, there is available the method introduced by Gauss. This method consists of replacing the series of surfaces and media by a system of six cardinal points and planes, by means of which graphic determinations become relatively simple. The refraction of the eye is estimated by the convergence of paraxial rays incident upon it when the image is sharply focussed at the retina, and this measurement may be taken at any cardinal point. Owing, however, to the simpler form of the equations involved it is convenient to refer the measurement to the first principal point of the eye. Further, as the two principal points are so close together in the eye, no great error is introduced if we sometimes regard them as co-incident and speak only of one principal point. It is well also to remember that principal point refraction, as it is called, is different from and always algebraically more than spectacle refraction, a value which is estimated at the principal point of the correcting lens. The latter, following Hess, is often called the corrective value of the refraction.

AXIAL AMETROPIA.

In considering the case of pure axial ametropia corrected by a non-refractive contact glass and a fluid meniscus of certain thickness, we shall assume that the individual optical parts of the system are surrounded by air, *i.e.*, an infinitely thin layer of air separates the contact glass from the fluid lens and the latter from the cornea. This assumption enables us to ignore the non-refractive contact glass entirely in order to ascertain the power of refraction and the position of the principal points, and to take account only of the fluid meniscus.

It is convenient to tabulate the following expressions:—

Vertex of cornea - - - - - - - -	S
Vertex of fluid meniscus - - - - - -	V
Radius of curvature of inner surface of contact glass - - - - - - - -	r_H
Radius of curvature of outer surface of contact glass - - - - - - - - -	r_K
Radius of curvature of outer surface of cornea -	r_C
Thickness of fluid meniscus (assumed $=0{\cdot}5$ mm.)	d_T
Refractive index of fluid meniscus - - -	n_T
Refractive power of fluid meniscus - - -	D_T
Principal points of fluid meniscus relative to air	$H_T H'_T$
Principal points of Ametropic eye - - -	$H_A H'_A$

The refractive power D_T of the fluid meniscus is as follows:——

$$D_T = \frac{(n_T - 1)\ [r_C - r_H + \left(1 - \frac{1}{n_T}\right) d_T]}{r_H\, r_C} \tag{1}$$

If the refractive power of the outer and inner surfaces of the fluid meniscus be represented by

D_{TH} D_{TC}, then

$$D_{TH} = \frac{(n_T - 1)}{r_H} \text{ and } D_{TC} = \frac{(1 - n_T)}{r_C} \tag{2}$$

Thus, it is possible to indicate the positions of the principal points H_T and H'_T.

$$VH_T = \frac{d_T\, D_{TC}}{n_T\, D_T} \text{ and } SH'_T = \frac{-\, d_T\, D_{TH}}{n_T\, D_T} \tag{3}$$

If the refractive power of the ametropic eye be assumed to be $D_A = 58{\cdot}64$ Dioptres and the positions of its principal points $S H_A = 1{\cdot}348$ mm. (in air) and $S H'_A = 1{\cdot}602$ mm. (in the vitreous), by ascertaining the distance (in air) between the principal points H'_T and H_A as

$$\delta = SH_A - SH'_T = 0{\cdot}001348\ mm. + \frac{D_T D_{TH}}{n_T D_T} \tag{4}$$

then the refractive power $D_{TA} = D_{HTA}$ of the whole system and the positions of its principal points H_{TA}, H'_{TA} can be calculated. Thus

$$D_{TA} = D_T + D_A - \delta D_T D_A \tag{5}$$

and

$$H_T H_{TA} = \frac{\delta D_A}{D_{TA}} \text{ and } H'_A H'_{TA} = \frac{-\, n\, \delta\, D_T}{D_{TA}} \tag{6}$$

n being the refractive index of the vitreous.

This determines the distance of the first principal point H_{TA} of the system from the first principal point of the fluid meniscus T and the distance (in the vitreous) of the second principal point H'_{TA} of the system from the second principal point H'_A of the eye. The distance of the principal points H_{TA}, H'_{TA} of the system from the corneal vertex is as follows:—

$$SH_{TA} = VH_T + H_TH_{TA} - d_T \text{ and } SH'_{TA} = SH'_A + H'_AH'_{TA} \quad (7)$$

As indicated in the table the thickness of the fluid meniscus T has been assumed as $d_T = 0{\cdot}5$ mm. but even in the case of other

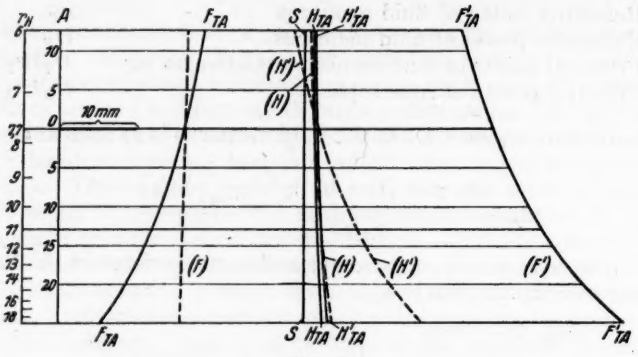

FIG. 5

values, *e.g.*, from 1·0 to 0·0 mm. there would be only a negligible change in the image.

These results are easily followed in von Rohr's graphic representation (Fig. 5). The corneal vertex is represented by the vertical line S and the anterior and posterior focal planes F_{TA} and F'_{TA} are drawn to scale representing a series of contact glass radii from 6 to 18 mm. and a range of ametropic refraction values of from + 12·5 D. to − 25·0 D. The scale used is shown on the emmetropic line ($A = 0$) corresponding to a cornea of radial curvature 7·7 mm.

When the positions of the principal points H_{TA}, H'_{TA} are plotted out for the entire series it is seen that the resulting curves deviate very little from the perpendicular throughout. Compared with the schematic normal eye there is found a slight anterior shift in hymetropia and a slight posterior shift in myopia. If the curves of the anterior and posterior foci are compared it is seen that this shift practically corresponds with the antero-posterior differences in length of the corrected eye, so that it is legitimate to conclude that contact glasses, unlike spectacles, correct ametropia, not by shifting the principal points but by altering the refractive power.

The comparison in this respect between spectacle correction and contact glass correction is strikingly demonstrated in the diagram, where the dotted lines F, F_1' H, H' represent the anterior and posterior foci and the two principal points of a spectacle corrected system. The spectacle lens is assumed to be infinitely thin and placed at the anterior focal plane, viz., 12 mm. in front of the corneal vertex. The dotted line F' is superimposed upon F_{TA} because of necessity the posterior focal plane in both methods of correction must be at the fovea. The relatively considerable change in position of the principal points in the spectacle corrected eye is apparent if one compares the dotted curves H and H' with those of H_{TA} and H'_{TA}. In accordance with this difference of principle between contact glass correction and spectacle lens correction, there follows that dissimilarity in the sizes of the retinal images, produced by the two methods, which underlies the faulty appreciation of perspective and judgment of distance associated with the latter.*

MAGNIFICATION OF THE RETINAL IMAGE.

In contact glass correction magnification of the retinal image is a result of two factors:—

(*a*) That of the afocal contact glass,
(*b*) That of the fluid meniscus in conjunction with axial length.

(*a*) In the case of an afocal contact glass, whose refractive index is $n_H = 1{\cdot}516$ and thickness $d_H = 0{\cdot}5$ mm. by applying formula (1), viz.

$$D_H = \frac{(n_H - 1)\left[r_H - r_K + \left(1 - \frac{1}{n_H}\right) d_H\right]}{r_H\, r_K} \tag{8}$$

we get

$$r_K = \frac{r_H - (n_H - 1)\, d_H}{n_H} = r_H + 0{\cdot}170 \text{ mm.} \tag{9}$$

The magnification V_H is equal to the ratio between the two radii of curvature of the contact glass r_K and r_H.

Thus, $$V_H = \frac{r_K}{r_H} = \frac{1 + (n_H - 1)\, d_H}{n_H\, r_H} = \frac{1 + 0{\cdot}170}{r_H} \tag{10}$$

Therefore, the magnification V_H increases with the refractive index n_H and thickness d_H and decreases with an increasing radius

*Strictly speaking, the disturbance of perspective is due to the dissimilarity in size of the angles W and W' (Fig. 4). The angle W' however, may be taken as a measure of the size of the retinal image.

of curvature of the inner surface. Within the ordinary limits of these factors the magnifying effect of the afocal contact glass on the retinal image varies between approximately 1 per cent. and 3 per cent. over the whole range of ametropia from myopia to aphakic hypermetropia.

(*b*) The magnification produced by the altered refractive power V_{TA} resulting from the fluid meniscus in conjunction with axial length.

$$V_{TA} = \frac{D_A}{D_{TA}} = \frac{D_A}{(D_T + D_A - \delta D_T D_A)} \qquad (11)$$

The dependence of the magnification value V_{TA} on the relationship between the contact glass radius of curvature r_H and the refraction A becomes clear in the diagram (Fig. 6) where curves are drawn to show the effect of an afocal contact glass; of a system comprising fluid lens and eye; and of thin spectacles worn 12 mm. from the corneal vertex.

These curves demonstrate that the value V_{HTA}, that is, the product of the value of the afocal contact glass magnification and of that due to the altered refractive power, increases in the case of $A = -20{\cdot}0$ D. to 1·5 and decreases in that of $A = +9{\cdot}0$ D. to 0·9. Highly myopic eyes would gain, therefore, a magnification of the retinal image equivalent to 50 per cent. as compared with normal

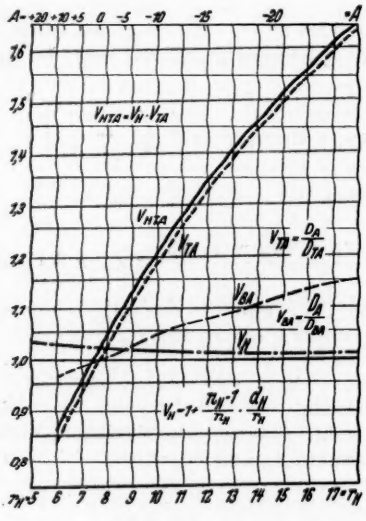

FIG. 6.

vision and highly hypermetropic eyes a reduction of up to 10 per cent. In other words, compared with spectacle correction myopic eyes would gain much greater acuity of vision from contact glasses, while hypermetropic eyes would suffer a slight reduction. This result is achieved without any disturbance of perspective. In eyes corrected by contact glasses the angle W (Fig. 4) remains unaltered ($W = W'$ for myopic, hypermetropic and emmetropic eyes).

In the event of a contact glass not being afocal but possessing a definite refractive power as a consequence of its outer surface being ground to have the properties of a plus or minus lens, the problem resolves itself into that of an afocal meniscus plus a positive or negative thin lens. The close apposition of this thin lens to the fluid meniscus prevents any great displacement of the principal points of the system, and the results arrived at above are still correct.

INDEX AMETROPIA.

The same fact, viz., negligible displacement of the principal points, applies also in the case of curvature or index ametropia, so that the degree of magnification of the retinal image defined in formula (11) differs but little from the unit value. In the particular instance of corneal astigmatism neutralization by the fluid meniscus results in equalization of the curvature deviation of the two principal sections. Both assume the same refractive power and exact the same positions for the principal points, thus ensuring a practically undistorted image such as is unattainable with spectacle correction. A problem of clinical importance, which has been exhaustively studied by Erggelet, arises in connection with corneal astigmatism corrected for near vision, viz., the relationship between the internal effort of accommodation and its external result. The disparity between the two reaches its highest degree in cases of mixed astigmatism but, as it is present in all varieties of ametropia, it will be considered in the next section.

ACCOMMODATION.

It is known that the act of accommodation causes very little displacement of the principal points of the eye. In Gullstrand's schematic eye the effect of accommodating 10·0 D. causes about 0·45 mm. backward displacement, and a difference of 0·5 mm. may be regarded as within the normal limits of error. The increase in refractive power of the crystalline lens of the eye during accommodation displaces to a negligible degree the principal

points of the system (contact glass + fluid meniscus + ametropic eye).

Early in 1925 Percival drew attention to a curious point which had often been suspected clinically but never fully understood. It is well known that convex spectacles worn for distance correction in the usual position, *i.e.*, 12 mm. in front of the corneal vertex, have the same effect as stronger lenses in contact with the cornea, while the reverse is true of concave lenses. Percival proceeds to show that for near correction this is no longer true. The spectacle lens, convex or concave, worn 12 mm. from the cornea, has greater power in every case than that of the same lens in contact with the cornea. The position is as follows. When the same correction is used for all purposes, the spectacle lens at 12 mm. has higher effectivity than a correcting lens when used for reading. To be effective for near work the power of the lens must be increased. This applies to plus and minus lenses.

In simple astigmatism, therefore, a stronger cylinder will be necessary for reading, especially in the case of high cylinders. This applies, however, only to simple astigmatism; it does not apply when sphero-cylindrical combinations or presbyopic additions are necessary. If +3·0 D. is the presbyopic correction, the + 3·0 D. " merely forms an image at a distance of the object (at 1/3 m. distance). Hence, no modification in the cylinder will be necessary, for the cylinder already found by trial that corrects the astigmatism for distance will still correct the error for reading." When no presbyopic addition is made, *i.e.*, when the same spherical correction is used for near work, the cylinder must be increased. Alteration of the spherical component may be neglected because for practically all purposes any spherical addition can be found by trial. When no spherical addition is required, approximately about 9 per cent. of the power of the lens required for distance must be added to produce the same effectivity when used for close work.

Later, in the same year, Erggelet drew attention to a discrepancy between the internal effort of accommodation and its external result in eyes corrected for ametropia. The following experiments should make the position clear.

A reduced schematic eye is set for emmetropia and a lens of + 4·0 D. added to it. This imitates an internal accommodative effort of 4 dioptres which would produce on the retina a sharp image of an axial object situated at a distance of 25 cm. The reduced eye is now lengthened so as to make it myopic and its ametropia corrected by placing a thin correcting lens at the usual distance of 12 mm. in front of the refracting surface. When the + 4·0 lens is again added, the eye is found to be focussed not for the same point as before but for a nearer one; in other words the

act of accommodating 4·0 D. (the internal effort) has produced a greater effect (the external result). A similar experiment with a shortened axis, simulating hypermetropia, produces a contrary effect. The practical importance of this is obvious in a condition such as mixed astigmatism corrected by a sphero-cylindrical combination placed 12 mm. from the corneal vertex, for whatever the internal effort the eye may make, it will be focussed in the primary section for a shorter distance and in the secondary section for a greater, or *vice versa*. In other words, in an eye whose astigmatism is fully corrected for distance, the astigmatism inevitable reappears during accommodation for near objects.

The experiment may be carried further by placing a thin correcting lens apposed to the refracting surface of the ametropic reduced eye so as to reproduce roughly the condition of a contact glass. The eye will now be found to focus with a + 4 D. lens in every case for the same near point as when adjusted for emmetropia.

If the relationship between the power of accommodation and its external result be

$$\mathfrak{A}_k = A_k \mathfrak{K};$$

in contact glass correction this becomes

$$\mathfrak{A}_k \approx A_k; \quad \mathfrak{K} \approx 1,$$

That is, the external accommodative result becomes almost equal to the internal accommodative effort and the factor of accommodation assumes values in the neighbourhood of 1. In comparison with spectacle correction this assists the hypermetrope on whom the discrepancy between effort and result has a disturbing effect, and to some extent handicaps the myope. The effect on the astigmatic is even more favourable.

APHAKIA.

This important variety of curvature ametropia may now be considered. Taking Gullstrand's values for the average radii of the corneal surfaces, viz., 7·7 and 6·8 mm. respectively and the refractive power $D_{\bar{A}}$ of the aphakic eye as that of the cornea, *i.e.*, 43·05 D., the principal points will lie about 0·05 to 0·0505 mm. in front of the corneal vertex. The focal distance on the image side corresponds to the axial length l. The magnification of the retinal

image $V_{HT\bar{A}}$ in comparison with that of the normal eye is approximately $58{\cdot}64 \times l \times V_H$. The comparison in regard to size of image between contact glass correction of aphakia and spectacle lens correction is shown graphically in Fig. 7. The curve $V_{HT\bar{A}}$ shows that for values over + 17·5 D. there is actually a diminution in size of the retinal image under contact glass correction. With diminishing amounts of aphakic hypermetropia there is a gradual increase. The curve $V_{B\bar{A}}$ for spectacle correction remains relatively

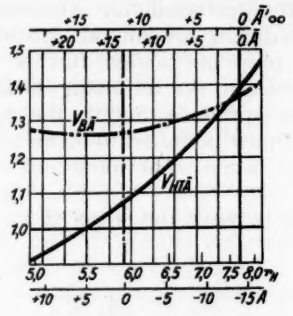

FIG. 7.

level throughout and roughly represents a 25 per cent. enlargement.

Practically this means that in unilateral aphakia where the other eye has useful vision binocular fusion becomes possible. The difference in size of the retinal images of the two eyes in aphakic anisometropia is not, however, the principal cause of diplopia. Where the power of fusion is normal the eye can fuse at least 10 to 20 per cent. of difference. The chief difficulty arises from displacement of the image by the prismatic effect of spectacle lenses of high positive value. The eye can fuse differences in size, but one eye cannot deviate, say 10° and the other 30°. With contact glasses the necessity to do so does not exist, so that diplopia cannot occur either from incongruity of size of image or from disturbances of the turning angle (*Blickwendewinkel.*)

THEORY OF CORRECTION.

The data required for theoretical correction are as follows:—

r_H = radius of curvature of inner surface of contact glass,
A = refractive error of the eye,
n_T = refractive index of the lacrimal fluid, viz., 1·336,
r_C = radius of curvature of the outer surface of the cornea.

Of these, the radius of curvature of the contact glass is known, being engraved on each trial glass. The amount of refractive error is estimated beforehand, by retinoscopy, ophthalmometry, etc. The refractive index of the lacrimal fluid is also known. With regard to the radius of curvature of the cornea, practically all authorities—Donders, Tscherning, Gullstrand—give much the same average figure, viz., 7·7 mm. Fig. 8 showing the distribution of a series of measurements, is from Tscherning.

If we assume an afocal contact glass and an infinitely thin fluid meniscus with refractive power D_T equal to the principal point

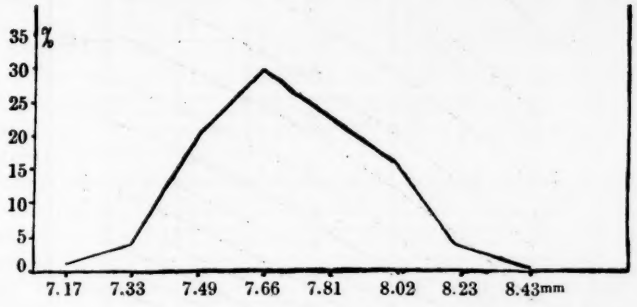

FIG. 8.

Distribution of corneal measurements (Tscherning).

refraction A of the ametropic eye, *i.e.*, $D_T = A$ and $d_T = 0$, by applying equation (1) we obtain the following relation for r_H.

$$\frac{1}{r_H} = A\,(n_T - 1) + \frac{1}{r_C} \qquad (12)$$

For every value of r_H it is now possible to determine a curve in the co-ordinate system r_C, A (Fig. 9). By means of this diagram it is possible to ascertain the best correcting test contact glass and also any additional refractive power that may be required.

As examples, take firstly a hypermetropic eye where $A = 8{\cdot}0$ D. The horizontal line responding to + 8·0 D. meets the vertical line representing a corneal radius of 7·7 mm. exactly on the curve 6·5. In this example, therefore, the eye is fully corrected by a test afocal contact glass $r_H = 6{\cdot}5$ mm.

Again in the case of a myopic eye $A = -3{\cdot}0$ D. and r_C, determined by the ophthalmometer, = 8·1 mm., the point of intersection is 1·0 dioptre distant from both the 8·5 and the 9·0 curves. This eye, obviously, can be fully corrected by an 8·5 test glass plus

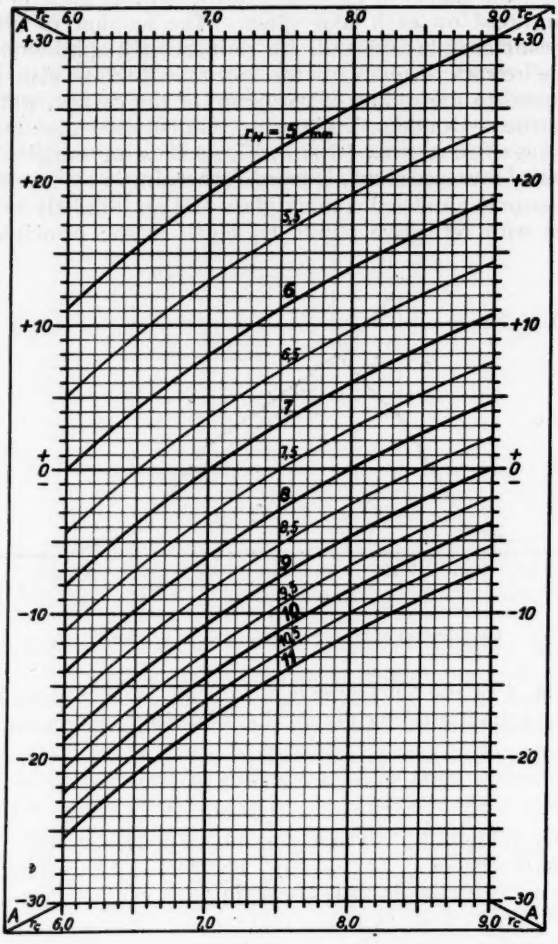

FIG. 9.

an additional refractive power of − 1·0 D. or by a 9·0 glass with a + 1·0 D. addition.

With the higher degrees of myopia and to a lesser extent with the higher degrees of aphakia a wider range of contact glasses is available as a basis on which a full correction can be prescribed by appropriate refractive corrections.

This is a great advantage. It is not always wise to prescribe the

contact glass that most closely approximates full correction. The larger the radius of curvature of the corneal portion of the glass, *i.e.*, the flatter the glass, the more likely it is to come in contact with the cornea. Numbers 10 and 11 often touch the cornea. When this occurs the cornea becomes deformed to assume the shape of the inner surface of the contact glass, and thus a correction is made. Contact glasses, both blown and ground, often press keratoconus flat, and no harm appears to be done. I have examined a patient who has worn blown contact glasses for conical cornea for 15 years, and although examination with the slit-lamp showed definite pressure on the apex of the cone, no sign of damage could be detected. It is just as well, however, to avoid contact with the cornea, and the aim in prescribing should be to utilise a contact glass with a corneal radius as nearly as possible that of the cornea itself. The residue of error can be corrected by super-imposing a lens of sufficient power on its outer surface. Failure to observe this principle explains the inability of many patients to become accustomed to their glasses.

The method here described can also be applied to astigmatism. The ametropia is estimated for one of the principal corneal sections, whether the primary or secondary is theoretically unimportant, and the appropriate contact glass determined in a similar manner. In the case of irregular astigmatism due to conical cornea or corneal nebulae it is best to fit a trial glass at random and test subjectively with convex and concave spheres until the maximum visual acuity is reached. The number of dioptres added is traced on the chart and the test glass whose curve most nearly corresponds is substituted. Plus or minus spheres are again added until a satisfactory correction is obtained. Occasionally a practical difficulty presents itself during subjective tests. Certain cases of both regular and irregular astigmatism, especially those of high degree, and even cases of axial ametropia, particularly hypermetropia, have defective form vision even when accurately corrected. It requires a good deal of experience to decide in those cases the best contact glass correction.

In the construction of the chart (Fig. 9) an infinitely thin fluid meniscus, $d_T = 0$ has been assumed. This assumption introduces a small possibility of error, which, however, is afterwards neutralized by the subjective test.

USES.

I propose to review the subject matter of this section briefly and inadequately. I do this deliberately because, although it is certain that contact glasses have great possibilities, my own experience is not sufficiently wide to enable me to foresee where

exactly their future lies, and I doubt if that of anyone else is. Various factors complicate the issue, among others the psychological one. It may happen that the psychology of the British people will prove to be on the whole unfavourable. At present contact glasses are a novelty. This fact attracts some and repels others. When the novelty has worn off and their use has become more common it may be that many who are now repelled will be willing to wear them. A good many at present undoubtedly find something rather repulsive in the idea of inserting a glass in the eye. There is the fear of discomfort and the fear that it is not safe. The latter I believe to be unjustified. A contact glass, owing to its position in the orbit, is well protected from injury, much better than a spectacle lens. Should one be broken *in situ*, the risk of penetrating the cornea is small. An illustration will make this clear. If a thin cover glass, such as is used for microscope slides, be placed on the back of the hand and shattered by a blow, the skin will probably escape injury. If, however, a cover glass is fixed an inch away and then broken by a blow that tends to drive the particles along the direction of force towards the hand, the chances are that some of the fragments will be driven into the latter. The former example is analogous to the contact glass; the latter to the spectacle lens.

It will require a much more extended use of contact glasses than obtains to-day before we know what percentage can wear them all day without discomfort. Undoubtedly many people do. On the other hand, a fair percentage appears to be unable to tolerate them for more than 3-6 hours daily even after prolonged trial. I do not think this is always the fault of the contact glass. I suspect the solution has something to do with it, or the state of the conjunctiva. The presence of even a low grade chronic conjunctivitis will often after a few hours wear render the fluid turbid and induce discomfort and lacrimation. With greater experience these and similar questions will doubtless be solved.

In the foregoing remarks certain indications for the use of contact glasses for refractive errors have either been expressly stated or are tacitly implied. Stress has been laid on the fact that their use confers on an ametrope appreciation of perspective and judgment of distance comparable to that of an emmetrope. This is true of monocular and still more so of binocular vision. By securing uniformity of size of the retinal images in anisometropia, by neutralizing corneal astigmatism, and by permitting a full range of movement of the eyes, they completely satisfy practically all the ocular conditions of binocular vision. In addition to these advantages there is the increased field of vision, which is so striking to patients, particularly high myopes, that they hardly ever fail to remark on it. I feel sure that the gain in these three

directions—monocular perspective, binocular fusion, and increased field of vision—should ensure for these glasses an extended use in certain occupations and pursuits, for example, speed-racing on land, sea and air, and many others not quite so sensational. Contact glasses so used, being maintained at the body temperature, have the additional advantage that neither fog nor rain can condense on them. Further they protect the cornea from wind and the eye from glare. The protection from the latter is enhanced by the tinted varieties.

I feel sure also that they will enter largely into sport. Even when they are tolerated only for a few hours they should prove of value in tennis, shooting, swimming, etc. Their extreme inconspicuousness, amounting almost to invisibility, should prove an attraction in other activities. The actress, for example, may wear them on the stage and the Society hostess at her receptions.

The use of contact glasses as an aid in the treatment of certain diseases of the eye is a field still largely unexplored. Prof. Heine's unrivalled experience in this connection has led him to certain conclusions which may be briefly summarized. Contact glasses, especially when tinted, are of great value in relieving certain symptoms of albinism, such as defective vision, photophobia, and even nystagmus. They may be used with advantage, for similar reasons, in cases of phlyctenular conjunctivitis associated with blepharospasm and photophobia in children. They are indicated in many varieties of keratitis, inflammatory, neuroparalytic and degenerative, and in plastic operations of the cornea they are valuable for maintaining the grafts in position. When used for the treatment of corneal ulcers continuous application of an antiseptic ointment can be secured by smearing the preparation on the inner surface of the glass. They have also been used in iritis.

In no class is the value of contact glasses more manifest than in the group of visual defects due to irregular corneal astigmatism. Examples with diffuse interstitial haze, with scattered nebulae, even cases with definite keratinization are improved, often considerably. In one case, a man with double conical cornea, vision in the better eye improved under contact glass correction from 2/60ths to 6/9ths partly. Conical cornea appears to be specially suitable for this form of correction. My own experience is confined to this one case. The condition is one that appears to be becoming rarer.

I have so far not used contact glasses for squint. I am told that there is no theoretical reason why a contact glass should not be made with a prism worked on its outer surface to neutralize convergence, and so maintain, before amblyopia develops, simultaneous vision in the two eyes. Practically, however, it would not be possible to keep the prism in its correct position.

For the stage after the onset of amblyopia an appropriate contact glass should make the perfect occluder. Its outer surface could be mottled like Chavasse glass sufficiently to cut down vision in the better eye to the necessary degree without altering its appearance. This suggestion is quite practicable, and it may prove to be of great value in the treatment of this troublesome by-product of squint.

In conclusion, I should like to record my great indebtedness to Dr. H. Hartinger and Prof. M. von Rohr, of Jena for valuable information acquired during conversations with them and from their published writings. The optical formulae in this paper are all derived from Dr. Hartinger's publications,* and have been revised by him. Prof. Erggelet, of the University of Jena, has also very kindly placed at my disposal the results of his considerable experience.

*See Zur optischen Theorie der Haftgläser. *Zeitschr. f. Ophthal. Optik*, Vol. XVIII, Heft 5 and 6, 1930.

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OPHTHALMO-MANOMETRY

BY

W. S. DUKE-ELDER, P. M. DUKE-ELDER AND J. C. COLLE

(FROM THE DEPARTMENT OF PHYSIOLOGY AND BIOCHEMISTRY, UNIVERSITY COLLEGE, LONDON)

ALTHOUGH of no small value as a clinical instrument when it is recognized that its readings cannot in any sense claim to scientific accuracy, the tonometer can in no sense be accepted as efficient for accurate experimental registration of the intra-ocular pressure. It is only by the method of manometry whereby the contents of the globe of the eye are put in direct relationship with a recording manometer by means of a cannula introduced into the anterior chamber that this can be attained.

The essentials of any good manometer are: (1) That it inscribes a curve which has a sufficient amplitude to show small changes in gradient; (2) that it responds without appreciable lag; (3) that it reproduces variations of pressure correctly as regards amplitude and phasic relations. In the special case of the eye the issue is complicated by the fact that if any fluid should enter or leave the eye while the cannula is being inserted or during the establishment of pressure equilibrium the intra-ocular conditions are gravely upset. An attempt has been made to overcome this complication by the use of a closed system of dimensions so small as to minimise the error in the micro-manometer introduced by Hering (1869), but an instrument of this nature suffers from the defect that the variations recorded are of quite insufficient amplitude to be adequately recorded. The great majority of observers have therefore employed a mercury (or saline) manometer provided with a special compensatory mechanism to prevent any change in the volume of fluid. The mercury manometer, however, violates the other two desiderata required of a manometer: it responds with a very appreciable lag, and the inertia of the mercury fails to reproduce the amplitude and phasic relations of the pressure curve with any degree of accuracy. These faults can be overcome by the use of an optical manometer whereby a column of mercury (or of saline) is replaced by a beam of light, which, having no appreciable inertia, responds to minute differences of pressure with the greatest accuracy. Manometers of this kind have been used comparatively rarely in ophthalmological research, and such types as have been described suffer from the lack of an adequate compensatory apparatus; moreover an optical manometer, like a spring balance, regulates only the differential pressure while the actual pressure level remains unrecorded. The instrument described in this paper,

which we have been employing for over two years, seems to circumvent these difficulties and may therefore merit a short note.

An optical manometer consists essentially of a small chamber connected with the eye by a cannula, the distal end of the chamber being closed by a membrane carrying a mirror. Variations of pressure in the eye are communicated to the membrane, the excursions of which are amplified and recorded optically by a beam of light. The efficiency of such a manometer depends on (1) its sensitivity and (2) the accuracy of its response. The sensitivity is a static factor referring to the magnitude of its response (*i.e.*, the excursion of the membrane) on the application of pressure. It may

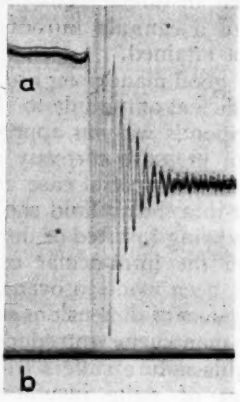

FIG. 1.

be increased by decreasing the tension of the membrane or by increasing its diameter. The only influence which may disturb the accuracy of the instrument is the natural frequency which every membrane in tension possesses whereby it tends to vibrate in its natural periodicity, and which may therefore interfere with the record of pressure. The accuracy of the response is thus a dynamic factor expressed by the ratio of the natural frequency of the manometer to that of the shortest component which enters into the pressure variation to be recorded. For accurate records the former should be four or five times as great as the latter, and if this is not obtained in practice, the registered curve will be distorted both in amplitude and phasic relations. In intra-ocular pressure readings a natural frequency of 150 to 200 is ideal.

The natural frequency is readily measured by observing the free oscillations recorded after the sudden release of pressure on the

membrane (Fig. 1): the natural period (T) is the duration of any double vibration, and its reciprocal (or the number of vibrations per second) is the natural frequency. In a simple manometer system the natural frequency varies directly as the "effective mass" and inversely as the "volume-elasticity coefficient": the first should therefore be kept as high as possible, and the second as low as possible.*

The effective mass is the theoretical mass, which, concentrated near the elastic membrane, determines the inertia of the system, and it is found to vary directly as the length of the system and inversely as its cross-section. The effective mass of the manometer is the sum of the effective masses of its component parts, the cannula, its connections, and the glass chamber, and care must therefore be exercised in their design so that no unnecessary constrictions exist and that they have the greatest diameters and shortest lengths compatible with convenience. The volume-elasticity coefficient is the ratio of the increase of pressure to the increase of volume which it produces, and is represented by the pressure required to move a unit volume of fluid past a cross section of the system near the membrane. In order to increase it all elastic structures (*e.g.*, rubber tubes) other than the membrane itself should be eliminated, the size of the membrane should be decreased, and it should be under great tension. There are, of course, limits beyond which the last two expedients cannot be forced, for such a procedure, by reducing the excursion of the membrane, lowers its sensitivity, although the effect may be compensated within limits by increasing the length of the recording beam.

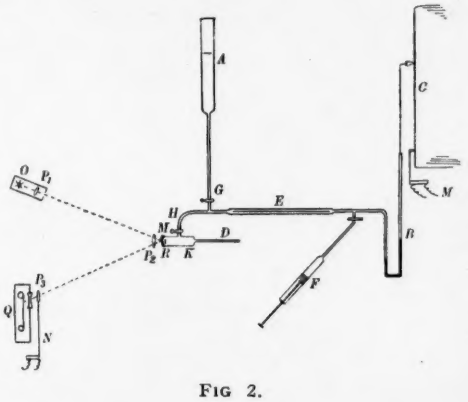

FIG 2.

The manometer seen in Fig. 2 represents a combination of the compensatory manometer with an optical manometer constructed on these principles. A cannula (D) made of platino-iridum and pointed with steel of an internal diameter of 1mm., leads into a

* Frank's formula is $T = 2\pi\sqrt{\frac{M}{E}}$, when T is the natural frequency, M the effective mass, and E the elasticity coefficient.

cylindrical glass chamber, the distal end of which is closed by a stretched rubber membrane (M). This membrane carries affixed to its edge a minute mirror from which a beam of light, derived from the source O and passing through a slit and an optical system (P_1, P_2, P_3), is reflected on a moving photo-film in the camera (Q). A second mirror (R) fixed immovably to the edge of the chamber serves as a base line, and the tracing recorded from it is interrupted by an electrically controlled time-marker (N). The glass chamber communicates with a mercury manometer (B) tracing on a kymograph (C) on which is recorded a second time-marker (M) synchronized with the first. Between the manometer tube and glass chamber there is interposed a compensatory apparatus of the type introduced by von Schultén (1884), consisting of a horizontal graduated capillary tube (E) containing an air-bubble, the movements of which can be controlled by a pressure syringe (F). Between this and the glass chamber is a reservoir (A).

The whole apparatus is filled with Ringer's solution to the entire exclusion of air, and the reservoir (A) is raised to the approximate height of the anticipated intra-ocular pressure (25 mm. Hg.) The cornea is nicked with a Graefe knife at the limbus in such a way that the point almost (but not quite) enters the anterior chamber: it is essential to prepare the way for the entrance of a thick cannula in this manner if the pressure equilibrium of the eye is not to be seriously disturbed. The stop-cocks at G and H are opened, and, with the fluid running out of the open cannula at this pressure, the latter is thrust through the cornea near the limbus to lie parallel to the plane of the iris in the anterior chamber. It is extremely important at this stage to avoid touching the iris, for even if the cannula rubs against it, an axon reflex is set up involving a capillary dilatation which upsets the intra-ocular pressure for a period lasting over several hours. As soon as the cannula is inserted, G is closed and equilibrium is established by manipulating the syringe F so that an air-bubble introduced into E is stationary: at this point the intra-ocular pressure is recorded on the mercury manometer. The glass chamber (K) is then clamped on to the same clamp-system which supports the head of the animal so that no strain is carried by the eye, and any movements are equally shared by the cannula and the animal's head. When the pressure has remained at a steady level for 10 minutes, the tap H is closed so that the chamber (K) alone remains in association with the eye: thereafter variations in the pressure are recorded optically on the film in the camera. After the experiment is finished the absolute pressure is again recorded, and the excursions of the beam of light on the film are calibrated from the mercury manometer.

Fig. 3 illustrates the results obtained in a simultaneous registration of the carotid pressure and the intra-ocular pressure of the dog. The lower curve which represents the intra-ocular pressure shows

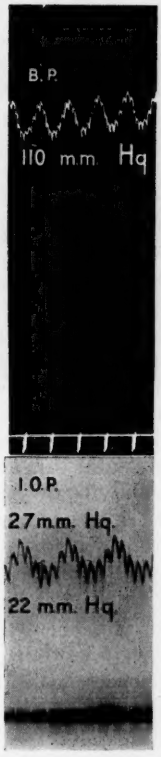

FIG. 3.

To obtain higher lateral magnification in the record the tracing of the intra-ocular pressure is running faster than that of the blood pressure (as 5 : 3).

how faithfully it follows variations in the blood pressure. The large waves follow the respiratory excursions, while the small waves mark the pulse-beats on which a dicrotic notch can be made out. It may not be generally recognized that in an adult dog lying completely at rest under ether-chloralose anaesthesia the former involves a pressure variation of 5 mm. of Hg and the latter of 1·5 mm. of Hg.

A CASE OF DERMO-FIBRO-LIPOMA OF THE CONJUNCTIVA ASSOCIATED WITH OTHER CONGENITAL ABNORMALITIES

BY

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WE report this case of congenital dermo-fibro-lipoma of the conjunctiva associated with other abnormalities, in the belief that it is of unusual interest.

In January, 1930, a boy, aged 3½ years, attended the Moorfields Eye Hospital. His mother had brought him on account of a swelling on the outer part of the right eye which she had observed since his birth. He had been troubled by recurrent attacks of inflammation in this eye, in the nature of a mild conjunctivitis.

He was the first child and except for a prolonged labour the birth was normal. When 3½ months pregnant, the mother had two teeth extracted from the right lower jaw. She remarked that at birth her son had a distinct cavity in the right lower jaw at a similar site to her extractions, and subsequently she noticed that his last tooth to erupt was also at this area. There was no family history of a congenital anomaly of the parents on either side.

Fig. 1 is a drawing of the right eye, and it shows the shape, size, and position of the swelling, which extended from the upper to the lower fornix, nearly to the outer canthus, and to within 4 mm. of the limbus, except at a position corresponding to 8 o'clock where a tongue-like process reached the limbal margin.

The surface was smooth and faintly lobulated; the colour, a pinkish yellow; and the consistence, soft-elastic. Projecting from the surface were four hairs, and it is thought that these were a factor in the recurrent attacks of mild conjunctivitis. The swelling was confined to the bulbar conjunctiva and subconjunctival tissues, and it could be moved over the globe. There was no clinical evidence of an association with an orbital neoplasm. The inner canthus was wider on this side than on the left and the caruncle was present. There was also a right convergent strabismus the cause of which proved to be mechanical, for it disappeared after removal of the tumour. The child was intelligent and appeared to have good visual acuity in each eye and presented no other ocular abnormality.

A general examination revealed certain other congenital defects.

Fig. 2 shows a marked facial asymmetry, the face being flattened over the right lower jaw; and it seemed on palpation that the

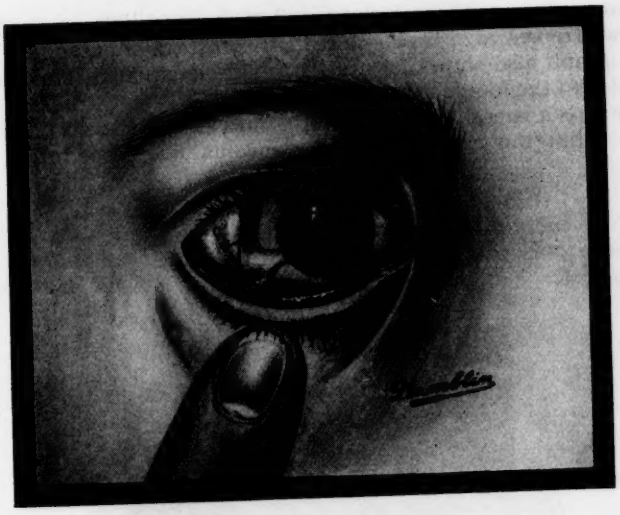

FIG. 1.

FIG. 2.

junction of the body and the ramus of the mandible on the right side was represented by a gradual curve instead of an angle. The photograph also shows an accessory auricle situated immediately anterior to the lobule of the right ear.

Fig. 3 is a lateral view of the right auricle. The auricle was well formed but the external auditory meatus was imperforate and

FIG. 3.

covered over by skin which extends from the tragus to the concha. Hearing, on the right side, was only slightly impaired on testing with a watch and tuning fork.

The teeth and remainder of the body presented no abnormality.

Radiographs of the skull, and particularly the mandible and teeth, were taken at University College Hospital, and Dr. R. W. A. Salmond was good enough to report on these.

Report of X-Ray Examination

" There is marked asymmetry of the lower jaws, that on the right side being smaller and less developed than the left. As regards the teeth, all the temporary ones in both the upper and

lower jaws are erupted and normal in number. None of the permanent ones have erupted in either jaw but the lower 1st molars are on the point of breaking through."

The boy was admitted to the Moorfields Eye Hospital and the swelling excised and submitted to histological examination.

Pathological Report

Fig. 4 is a microphotograph of a piece of the section.

The surface of the swelling is covered by stratified squamous epithelium. There is no superficial keratinization. Beneath the

FIG. 4.

Microphotograph which shows from above downwards:—
Stratified squamous epithelium.
Sub-epithelial connective tissue.
Hair follicle.
Blood vessels.
Bundles of fibrous tissue and unstriped muscle fibres.
The lobules of fat are not shown in this microphotograph.

epithelium there is a thin layer of connective tissue containing hair follicles and capillaries, and deep to this there is a mass of fibrous tissue and unstriped muscle, the fibres of which are arranged in irregular interlacing bundles. This fibro-muscular

tissue is denser and thicker in the centre of the tumour than at the periphery and it covers a mass of fat which is divided up into lobules of various shapes and sizes by strands and trabeculae which pass into it from the overlying fibrous tissue. Hair follicles and blood vessels are also present in this mass of fibro-muscular tissue.

Pathological Diagnosis.—Dermo-fibro-lipoma of conjunctiva. The right convergent strabismus disappeared and recovery was uneventful. The boy remains in good health. It is proposed to deal with the other congenital abnormalities at a later date.

In the literature, cases of dermo-lipoma are reported associated with other congenital defects. Of particular interest is that case described by Lamb and Hardy in which the following anomalies were also present; an amniotic band from the outer canthus to the cheek; an osseous defect in the skull at the pterion; an undescended testis; hypospadias; fat pads over the symphysis pubis; a coloboma of the iris; and mental backwardness.

Several observers have stated that hairs do not occur in these tumours before puberty, but this was not so in the case we have reported above.

We express our thanks to Sir John Parsons for permission to publish this case.

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SCLERITIS AS A SEQUEL OF HERPES OPHTHALMICUS

BY

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DURING the last year there seems to have been a great increase in the prevalence of herpes ophthalmicus, and of the cases I have seen, four have later developed scleritis, three of these being of a characteristic type, the fourth a sclero-keratitis.

References to this condition in the literature are few, and some of these rather vague.

The course of a typical case is as follows:—

About 2-3 months after an attack of herpes ophthalmicus, usually accompanied by some irido-cyclitis, the patient complains of redness and pain in the affected eye. On examination one or more nodules of a dark red colour, and about the size of a lentil, are found beneath the conjunctiva, which is much injected, and has a glossy surface. The nodules are very slow in subsiding, usually taking months to do so: gradually getting smaller and darker, almost plum-coloured, and finally disappearing, leaving sharply defined slaty grey areas in the sclera where they have been situated. The conjunctiva over these areas is freely movable, and apparently normal.

The iris is atrophic, often in patches, which are found in that part of the iris nearest to the slaty areas in the sclera. The pupil often remains quite inactive and dilated. The condition is liable to relapse, and fresh nodules may arise in areas of the sclera hitherto unaffected. The great majority of the cases are over 50 years of age. In addition to the characteristic condition described, in which there is no concurrent corneal involvement, a sclero-keratitis sometimes occurs.

Genet[1] quotes two cases, and divides the course of the condition into four stages:—(1) Patches of intense conjunctival hyperaemia with a glossy surface. (2) The appearance of raised nodules under the conjunctiva. (3) The return of the conjunctiva to its normal colour, leaving the nodules resembling those in episcleritis. (4) The disappearance of the nodules leaving flat slaty grey patches under the conjunctiva, which appears normal. He describes the lesions as essentially scleral, not corneal or conjunctival, and mentions that paralysis of the pupil is associated.

He thinks that the condition may be an affection of the sympathetic nerve twigs accompanying the first division of the fifth nerve.

His first case is that of a man aged 60 years, who had herpes in January, 1926, and began to develop the nodules in March, 1926. The second is that of a man aged 60 years who had herpes in March, 1926, and developed nodules in April or afterwards, and was not seen again until November, when he had the typical slaty patches.

Lauber[2] quotes the case of a woman aged 57 years, who developed a swelling in the sclera six weeks after herpes. Her pupil was not paralyzed.

Thompson[3] describes "herpetic eruptions" on the sclera, which appear as small reddish nodules, or larger nodules with a transparent centre. His four cases are as follows:—

(1) A man aged 41 years, who developed a nodule three weeks after the onset of herpes: the nodule left a discoloured patch behind it. The Wassermann reaction was positive in this case.

(2) A woman aged 36 years, who developed nodules two months after herpes.

(3) A man aged 66 years, who had three reddish swellings in the sclera 14 days after the onset of herpes.

(4) A woman aged 57 years, with nodules five months after herpes. Ten months after only slight discolouration of the sclera remained.

Wilbrand and Saenger[4] mention scleritis as a complication of herpes ophthalmicus, but usually a sclero-keratitis. They quote Kendall, J.[5] as having found scleritis in three cases out of 17 of herpes ophthalmicus.

Meller[6] mentions the condition, and quotes several of the above cases.

Verderame[7] describes a case of sclero-keratitis with serous cyclitis and raised tension coming on ten weeks after the onset of herpes ophthalmicus. He thinks that the condition is rheumatic in origin.

My own cases are as follows:—

Case I.—E. P., male, aged 63 years, attended St. Thomas's Hospital March 20, 1931, with a history of herpes ophthalmicus (left side) beginning 21 days before. Some scarring of the forehead was present, but no vesicles remained.

The right eye was normal. The left cornea was hazy, especially below, but did not stain. Both ciliary and conjunctival vessels were injected, and there was some iritis, with a few spots of fine K.P. The tension was normal.

He was admitted and treated with atropine and heat: the cornea cleared, the pupil remaining half dilated.

He was discharged March 28, 1931, R.V. = $6/6\,\bar{c} + 1{\cdot}0$ D. sph. L.V. = 6/12 most $\bar{c} + 1{\cdot}0$ sph.

On April 7, 1931, two large patches of scleritis appeared at 5 and 7 o'clock, deep red in colour and covered by injected, glossy conjunctiva. Some atrophy was noted in the lower part of the iris with a network of delicate vessels coursing over the surface. Vision as before.

Case II.—S. G., female, aged 77 years, attended St. Thomas's Hospital June 23, 1930, with a history of herpes ophthalmicus (right side) three months previously, and inflammation of the right eye for a fortnight. There were no signs of active herpes.

Right Eye.—Vision = 6/18. Much conjunctival injection. There were two large plum-coloured masses in the sclera at 7 and 11 o'clock, about the size of split peas. They did not reach to the limbus. The pupil was dilated and inactive. The iris was atrophic to the temporal side, especially in one patch at the point nearest to the lowest patch of scleritis. There were two tiny superficial scars in the cornea. Fine pigmented K.P. spots were present, and there were some lens striae. The fundus was normal.

Left Eye.—Vision = 6/36. Considerable lens opacity. Otherwise normal. The patient was offered admission, but refused, so she was treated as an out-patient with atropine and diathermy, and given a salicylate mixture.

The condition continued much the same, except that two more nodules, rather smaller, appeared in the nasal half of the sclera.

The Sachs-Georgi reaction was negative, and no dental sepsis was present. Examination of the ears, nose, and throat was negative, except for some age deafness.

On July 27, 1930, she consented to come into hospital, and was an in-patient until August 23, 1930, when she was discharged, the nodules being much flatter.

Present State.—R.V. = 6/18 pt. $\bar{c}$ + 1·5 D. sph. Pupil dilated and inactive. Iris atrophy as before. Cornea as before, except that the K.P. has shrunk a little. Four slaty grey patches mark the nodules of scleritis. These are covered by conjunctiva which appears normal, and is freely movable over the patches. Lens and fundus as before.

Case III.—G. B., male, aged 66 years, attended the Royal Westminster Ophthalmic Hospital on April 5, 1930, with a history of herpes ophthalmicus (left side) commencing seven weeks previously. Well-marked scarring of the left side of the forehead and nose was present.

Right Eye.—V. = 6/9 $\bar{c}$ glasses. Pupil active. Fundus normal.

Left Eye.—V. 6/60 $\bar{c}$ glasses. Pupil active. One tiny isolated staining point on the cornea. Fine K.P. Two patches of scleritis, one at 5 and one at 11 o'clock. Treated with atropine and hot bathings; the condition slowly improved, though two small fresh

nodules appeared, one on June 14, 1930 and another on June 28, 1930.

The Wassermann reaction was negative, and no focal sepsis was found by examination of the teeth, and the ears, nose, and throat.

By the middle of July the nodules had settled in flat patches, and the patient was not seen again until January 31, 1931, when he attended with two large nodules at 3 and 5 o'clock. Two more nodules made their appearance in the next day or two, and he was admitted to hospital (February 2, 1931). He was treated with atropine and heat, given a salicylate mixture, and calcium chloride ionization to the left eye.

February 14, 1931. Discharged, Nodules almost flat, except that at 3 o'clock. Much K.P. still present. Fundus normal. Vision as before.

Case IV.—G. C., male, aged 63 years, admitted to the Royal Westminster Ophthalmic Hospital from an infirmary, April 5, 1930, with a history of R. herpes ophthalmicus since February 2, 1930. Some herpetic lesions were still active, the nasal branch of the nerve being involved. There was a large ulcerated patch the size of a shilling on the brow.

Right Eye.—V. = H.M. Patch of ulceration covering the whole of the lower half of the cornea. Large hypopyon. Complete external ophthalmoplegia and ptosis, also some weakness of the orbicularis.

Left Eye.—V. = 6/6 $\bar{c}$ glasses. Normal in all respects.

The patient was treated with atropine and heat, and a partial lateral tarsorrhaphy performed.

On May 28, 1930, he was discharged, with the herpetic lesions quite healed, and the ocular and lid movements normal. There was a dense corneal scar obscuring the pupil. On June 25, 1930, a patch of scleritis appeared, continuous with the corneal scar. This cleared slowly, but did not leave a slaty grey area. The vessels in this area are still very numerous and dilated. R.V. = H.M. at 1 metre. L.V. = 6/6 $\bar{c}$ glasses.

I am indebted to Mr. Hudson for permission to publish Case I, and to Mr. Doyne for Case II.

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NEUTRALIZATION IN DYNAMIC RETINOSCOPY

BY

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DYNAMIC retinoscopy, briefly defined, is that method of retinoscopy where the accommodation either alone or in association with the convergence is brought into play during the test. There are various ways and means of arousing and varying this accommodative activity and a number of techniques have been developed to meet such special needs. These techniques differ radically in many ways from the technique of static retinoscopy. It is the purpose of this article briefly to sketch one of these points of difference and its significance.

In static retinoscopy, our test ends when neutralization of the light-and-shadow movement is obtained. Some watch for actual neutralization, while others watch for the first light reversal, taking the lens just weaker as the one presumably giving neutralization. Whether we use the one method or the other, we always find that a stronger lens than the one that caused neutralization causes distinct reversal of movements. Thus if an initial " with " movement was neutralized with a plus 2·0 D., a plus 2·25 D. will cause a distinct "against" movement. Or, similarly, if an initial " against " movement was neutralized with a minus 2·0 D., a minus 2·25 D. will cause a distinct " with " movement. We therefore have to deal in static retinoscopy with but *one* neutralization lens.

It is quite different in dynamic retinoscopy. Here we generally have not one neutralization lens, but a series of such lenses, the lowest powered and the highest powered of this series being conveniently termed the low-neutral and the high-neutral respectively. Between these two we have the neutral range.

The following illustration will explain the foregoing. Say we make a binocular dynamic retinoscopy test by instructing the patient, who is already wearing his statically found correction, to fix binocularly the letters on a small chart attached just above the mirror of the retinoscope. The examiner preferably works along the median line of the patient, holding the retinoscope so that it is equally distant from the two eyes of the patient. From this position the examiner rapidly and alternately " refracts " each eye. The size of the type used on the fixation chart varies with the purpose of the test. This is a feature I shall briefly touch upon in the course of the discussion. Assume the test is made at a distance of 13 inches, necessitating a normal convergence of three binocular metre angles and three dioptres of accommodation.

Suppose we find in our test that the initial movement is " with."

Say, with O. U. plus 1·0 D. (added to the distance correction) we get neutralization. We proceed with stronger plus lenses and continue to get neutralization until we reach say plus 2·5 D. when we get a definite " against " movement. The first lens that gave neutralization was plus 1·5 D. We now have a low-neutral of plus 1·0 D., a high-neutral of plus 2·25 D., the strongest lens before reversal, and a neutral range of plus 1·25 D.

What is the significance of the low neutral, the high-neutral and neutral range? This depends upon various factors, viz., age, general vitality, occupation, working habits, refractive error, condition of the ocular muscles, etc. But in general, we can say this. The low-neutral represents accommodative *insufficiency*. For this " with " movement shows there was not enough accommodation used for the distance of the chart. It took a plus 1·0 D. to bring up the deficiency of accommodation. This deficiency is not necessarily absolute, rather is it relative to the amount of convergence used, in our illustration three binocular metre angles. The neutral range of 1·25 D. shows either accommodative *inefficiency* or negative relative accommodation depending upon the size of type used in the test. Where large type is used, such as can be distinguished under a blur of 0·5 D. to 1·0 D., then the neutral range represents inefficiency of accommodation. This is shown by the tendency of the accommodation to relax and let go as soon as plus power is applied to take its place. The inefficiency may be due to exhaustion incident to general bodily weakness or it may be due to a local condition such as beginning paresis. If the type used in the test is of the very fine variety such as to necessitate exact focussing, then the neutral range represents the negative relative accommodation. This is the amount of accommodation that can be forcibly relaxed with a fixed convergence in the interests of clear and single binocular vision.

When coarse type is used the high-neutral represents the strongest lens aid necessary in order to bring the accommodation and convergence into a comfortable, physiological adjustment. When fine type is used this lens represents the maximum value of the negative relative accommodation at the distance of examination. A small allowance of about 0·5 D. should be made in the above calculations because of a so-called lag of accommodation due, according to Prof. Southall, to the chromatic aberration of the eye. Apart from this allowance it is a matter of judgment to decide whether or not the full value of the high-neutral is to be given as a reading addition in any particular case. But the fact is that the finding of these three values, the low-neutral, the high-neutral and the neutral range will often clear up an obscure case of refraction where the correction based upon static retinoscopy, subjective testing and the subjective determination of the near point proved unsatisfactory.

ABSTRACTS

I.—CORNEA

(1) **Knapp, Arnold (New York).—Aetiology and the treatment of keratoconus.** *Trans. Amer. Ophthal. Soc.*, Vol. XXVII, p. 63, 1929.

(1) **Knapp** in this paper, gives an account of the aetiology and treatment of keratoconus. He describes the cause of keratoconus as an aberration in development due to some failure in the normal toughening process which takes place in the tissues. The corneal tissue becomes stretched and the intra-ocular pressure may be normal or even sub-normal. The condition first attracts attention in adolescence. Some of the affected patients are poorly nourished anaemic females who show signs of hypothyroidism. Associated physical signs may be dry skin, increased sweating, fragile nails, loss of hair, hypertrichosis, lymphocytosis 40-58 per cent., increased coagulability of the blood, and a low basal metabolic rate.

Török and Redway have described decalcification in the cranial bones of three female patients suffering from keratoconus. von Hippel and Schnaudigel consider that the thymus plays a part in the aetiology of this disease, and Stähli attributes familial and hereditary factors to it. Jaensch suggests that there is a hereditary predisposition comparable to that of myopia.

Knapp describes six patients in whom there was mild anaemia, thyroid deficiency, and low blood pressure. The blood chemistry, radiographs, and calcium figures revealed no abnormality. The basal metabolic rate was low in two patients only.

He discusses the relative value of treatment by contact glass, trephine, and electro-cautery. In performing cauterization atropine and cocaine are instilled into the affected eye, the apex of the cone is carefully localized with a Placido's disc, and the cautery applied to the cornea to make an interrupted Maltese cross pattern, *e.g.*, the cauterization stops short of the apex at the centre and the canal of Schlemm at the periphery.

Atropine ointment and a binocular bandage are used for 8-14 days, and a firm monocular bandage is applied for 5-6 weeks. After this the eye is bandaged for a further six weeks during sleep only.

The complications that may arise are herpes of the cornea, superficial punctate keratitis, hemicrania, corneal fistula, panophthalmitis, secondary glaucoma, and slow restoration of the anterior chamber.

H. B. STALLARD.

(2) **Berg, Fredrik (Göteborg).—The influence of the lids on the curvature of the cornea. (Ueber die Einwirkung der Lider auf die Form der vorderen Hornhautfläche).** *Acta Ophthal.*, Vol. VIII, p. 1, 1930.

(2) **Berg** recalls that the cornea is more spherical centrally than peripherally, the peripheral flattening taking place more abruptly above than below, and more on the nasal side than on the temporal. He points out that the curve of the horizontal meridian is more regular than that of the vertical. In fact the vertical meridian has an area of increased refraction at about 15° from the centre: it is beyond this band that the peripheral flattening sets in. This area of increased refraction corresponds to the upper lid marginal line described by Hardmann, a line that can occasionally be seen to run across the upper part of the pupillary area, especially noticeable when the eye is made to look downwards. It is most frequently seen in the young and middle-aged, and more marked in cases of chronic conjunctivitis and blepharitis. The majority of observers are against regarding it as mechanically produced by pressure from the lid, believing that it is probably due to some physical or optical changes produced by imbibition or some similar cause.

The author gives curves of horizontal and vertical meridians plotted out by measurement with a modified Javal-Schiötz ophthalmometer, and these clearly bring out his contentions. He agrees with Gullstrand in regarding the peripheral flattening of the cornea as due to pressure of the lid, the flattening itself producing compensatory changes in corneal curvature, either in greater central curvature (producing regular astigmatism) or in greater curvature in the area adjacent to the flattened part (producing Hardmann's line.) He gives the horizontal curve of a case in which a chalazion centrally situated in the upper lid produced not only a central depression, but also a peripheral elevation. A week after operation the curve had assumed a much smoother course.

ARNOLD SORSBY.

(3) **Nicolato, Angelo (Pavia).—Removal of the transparent lens in the surgical treatment of conical cornea. (L'estrazione del cristallino transparente nel trattamento chirorgica del cheratocono).** *Arch. di Ottal.*, February, 1920.

(3) There are three ways, says **Nicolato,** in which conical cornea may be favourably affected; by reducing permanently the intra-ocular pressure; by increasing the resistance of the cornea; and by altering its curvature. He has not had any considerable success by any of the usual methods, but has been encouraged by

the results which he has obtained after removing the lens. He thinks that the bad results of this operation in high myopia, are due to the pathological changes which high myopia brings about in the several deeper structures of the globe. When the eye as a whole is healthy as is the case in conical cornea, the operation has no special risks; it acts favourably both by reducing the intra-ocular pressure and by lessening the acquired myopia.

HAROLD GRIMSDALE.

(4) **Rugg-Gunn, A. (London).—Contact glasses for ametropia.** *Lancet*, November 15, 1930.

(4) " While the use of contact glasses and their possibilities cannot yet be said to have been fully explored, my brief experience has already convinced me that they have come to stay, and that in the future they will be found to constitute a very important addition to the methods now available for conserving and treating defects of vision."

So runs the concluding sentence of **Rugg-Gunn's** article. The slight ambiguity of the last clause is apparently due to wrong punctuation. The difficulties and disadvantages of the use of these glasses, as well as their undoubted possibilities in certain cases can readily be appreciated on perusal of this somewhat optimistic article, which does not lend itself to useful condensation.

ERNEST THOMSON.

(5) **Heine, Leopold (Kiel). — The use of contact glasses.** *Lancet*, March 21, 1931.

Greeves, R. Affleck (London).—A method of inserting contact glasses. *Lancet*, April 4, 1931.

(5) That contact glasses may be of service in certain cases seems to be admitted. That their application by the surgeon and afterwards by the patient is equally troublesome—the French word *fâcheux* and the Scots allied word *fashious* best express the meaning—is certain. In the *Lancet* for November 15, 1930, Rugg-Gunn described the glasses, their peculiarities of shape and the difficulties in connection with their application. He also stated that the majority of patients acquired tolerance surprisingly soon.

Heine, who has already published work on the subject, refers to Rugg-Gunn's article in the *Lancet* and seems rather to amplify the difficulty of the task of ascertaining the correct curvature, the scleral radius (the radius of the contact ring) and the actual application of the glass to the patient's eyeball. He points out that the surgeon should have a set of glasses of more ample range

than that mentioned by Gunn. He also says that " It is of considerable value for the patients to be given, immediately after the examination, the identical glass which they selected; this has psychological value, as patients are often unable to get the glass in and out when it comes to them from the makers after a few days, even though it is, in fact, a perfect fit." The details of the application and removal of these glasses must be sought in the various original articles, but it may be said that the principle is not unlike that of the familiar " sucker," except that in the case of the contact glass the fixed element is the glass and the elastic element is the eyeball, so, at least it appears to the reviewer. Two more short quotations from Heine's article may be given: " If all these points (*i.e.*, about the proper selection and fitting of the glass) are remembered, failures are very rare. There will always be some people whose eyes are so shaped that a spherical glass cannot adhere to them, and there will always be sensitive patients who cannot get accustomed to wearing this uncomfortable fitting on the most delicate surface in the body." Again, "All the writers on contact glasses in the past have used a fixed scleral radius of 12 mm. and that is the reason why experiments on this form of correction—which have been made for the last 100 years—have hitherto all failed. It is not the optics of the method that constitute the difficulty, but the application of the glass to the cornea, which demands not only correct scleral radius but also a good relation to the optical dimensions." The list of ocular conditions in which contact glasses are of service is quite long, so long, in fact, that one cannot help feeling that the author has overstepped the line which separates the practical from the ideal. Reports of ten cases are added at the end of the article. These are described as " illustrative " and one is led to assume that Heine must have very considerable experience in the use of contact glasses.

Affleck Greeves refers to the articles by Rugg-Gunn and Heine. He deals with only one case and especially with the method of insertion. The reviewer has refrained from the attempt to epitomize methods of application, while full transcription would occupy too much space. Therefore, readers must go to the originals for this. It may be said that the principal difficulty encountered by Greeves was the avoidance of the air bubble between the glass and the cornea, the same air bubble in fact which would vitiate the efficiency of the schoolboy's sucker if he did not step solidly on his apparatus. Here, in the case of the oculist, it is a case of *suaviter in modo* and not *fortiter in re*. Greeves's method avoids the air bubble but at the expense—in both senses of the word—of an assistant.

ERNEST THOMSON.

(6) **Mamoli.—Contact lenses and their advantages. (I Vetri Corneali (Vetri a Contatto) e Loro Applicazioni).** ***Lett. Oftal.***, February, 1931.

(6) **Mamoli** reminds us that contact lenses are no new thing. Fick, in 1888, to do away with the difficulties of correcting gross errors of refraction such as occur in conical cornea, suggested the use of a thin shell of glass with parallel spherical surfaces, applied to the cornea; the space between the shell and the eye was to be filled with some bland solution.

These shells were made by blowing, and therefore it was difficult to ensure that the optical effect obtained was that required since the curvature was less easily controlled than by grinding; but, on the other hand, Mamoli states that they were worn with less inconvenience; presumably because the surface of a blown sphere is smoother, and less irritating than a ground surface. In any case their employment is of limited scope.

HAROLD GRIMSDALE.

(7) **Pischel, Dohrmann K. (San Francisco).—Tattooing the cornea with gold and platinum chloride.** ***Arch. of Ophthal.***, February, 1930.

(7) **Pischel's** technique for tattooing with gold chloride is as follows. The cornea is anaesthetized with cocaine but no adrenalin is used, as it is a reducing agent. The area to be stained is outlined carefully with a knife or large trephine and the epithelium thoroughly and evenly scraped off. The solution of gold chloride should be of 2 per cent. strength with sufficient bicarbonate solution added to render it just faintly acid to litmus paper. It is applied on a piece of cotton wool large enough to cover the required area, the wool being pressed out so as not to be dripping wet. A fresh applicator is used every minute, three minutes' treatment produces a brown, and five minutes an almost black stain. Very dense scars may need a 3 per cent. or possibly a 5 per cent. solution. Any variety of scar may be treated, even thin staphylomatous ones with iris inclusion. The results are fairly gratifying though in the course of 6-8 months, the stain may fade a little, this fading being more marked if the leucoma be a vascular one. Platinum chloride would seem to give a dense and more permanent blot. The technique is to scrape the epithelium as for gold chloride and then stain the area with fluorescein after which it is washed with sterile distilled water. Two per cent. platinum chloride is then applied in the same way as the gold chloride for two minutes, when it is reduced by hydrazine hydrate instilled by a dropper. The latter is washed out with distilled water after 25 seconds, two minutes later the eye is irrigated with normal saline.

F. A. W-N.

(8) **Shoji, Y. (Fukuoka, Japan).—A pigmented network of the posterior surface of the cornea. (Sur un réseau pigmenté à la face postérieure de la cornée).** *Arch. d'Ophtal.*, March, 1930.

(8) The condition here recorded appears to be quite unusual; indeed Shoji in a comprehensive search has failed to find records of any similar case. The coloured illustrations of the pigmented area, seen with an ordinary loupe and with the corneal microscope, give a much better idea of the condition than can be conveyed by a written description.

The patient, aged 64 years, had undergone operation for cataract in both eyes, eight years previously, and came under observation for failing sight due to secondary cataract. The changes on the cornea were present in the left eye only. The pigmented network occupied a circular area of 3 mm., in the centre of the cornea, and had a brown colour similar to that of the iris. Seen with the slit-lamp the filaments appeared as brilliant golden threads on the black back-ground of the anterior chamber. There were no points of adhesion between the pigmented patch and the iris or the opaque capsule. On the back of the cornea there were also some brown pigmented dots, placed around and 1 mm. from the edge of the circular patch. Attached to the anterior surface of the iris near the pupillary margin were some small brown fibrils, the distal ends of which were free in the anterior chamber. All these changes are well shown in the coloured plate.

The author discusses very fully the possible origins and mode of development of this pigmented network: he concludes that it is the result of an anomaly in the early stage of the development of the eyeball. A comprehensive list of references is appended.

J. B. LAWFORD.

(9) **Friedman, Benjamin (New York) and Roth, Andras (Budapest).—Argyrosis corneae.** *Amer. Jl. of Ophthal.*, December, 1930.

(9) **Friedman** and **Roth** examined the corneae of 12 patients with argyrosis due to prolonged treatment for trachoma with silver salts. They found corneal involvement in 10 of these cases. It took the form of a pigmented ring the densest portion of which was towards the limbus. The colour variation from the strongest to the weakest cases was from golden brown, through yellow-green to ultramarine. The pigment was found to lie between Descemet's membrane and the endothelium, and the more pronounced the pigmentation, the further it came forwards into the substance of the cornea. There was also in some cases, an argyrosis of the lens, appearing as a yellowish reflex from the anterior capsule and

as a diffuse yellowish colouring of the posterior capsule and the adjacent cortex. The silver is probably precipitated as a mucoid and possibly also as albuminate, carbonate and chloride. The deposition of particles near the endothelium is explained by the latter having some vital quality which partly prevents the passage of solutions of heavy metals. There is thus a higher concentration of the solute near the endothelium with consequent precipitation. The same is also probably true of the lens and the reasoning applies to other metals such as copper. Since Vogt in 1929 extracted large amounts of copper and silver from spleen, liver, and kidney of a patient with hepato-lenticular disease a similar explanation has been advanced for the formation of the Kayser-Fleischer ring.

F. A. W-N.

(10) **Marinosci (Taranto).—Corneal sensitiveness in health and disease. (Sulla Sensibilita della Cornea allo Stato Normale e Patologico).** *Lett. Oftal.*, September, 1930.

(10) **Marinosci** has measured the sensitiveness of the cornea in different areas and in different conditions of health. As a means of measurement, he made use of hairs of different thickness and assumes that the stimulus given by the hair is more or less proportional to its thickness; the hairs had thicknesses from 25μ to 500μ. The thinnest hair gave no sensation to normal corneae and he has chosen the hair of 50μ as the base of measurement.

In normal people the periphery of the cornea is somewhat less sensitive than the central area, and this difference is specially marked in those who have *arcus senilis*. He found in epileptics almost constantly, a great difference between the two eyes; one eye being normally sensitive to a hair of 50μ and the other needing a hair of 170μ to provoke sensation.

Generally, when the cornea was inflamed and infiltrated, the sensitiveness was reduced but in cases of abrasion, where the nerves were exposed, there was hypersensitiveness.

A number of charts are given showing graphically the stimulus required in the different parts and conditions to provoke sensation.

HAROLD GRIMSDALE.

(11) **Toulant, P. (Algiers).—Vaccinal keratitis. (La Kératite vaccinale).** *Arch. d'Ophtal.*, April, 1930.

(11) Ocular lesions of vaccinal origin are comparatively rare, only about 100 cases being on record. Of these, the large majority affect the lids and conjunctivae. Corneal lesions are more uncommon; **Toulant** has found reports of 24 examples and has knowledge of a few unpublished cases. He now records a typical

instance under his own observation. This occurred in a female who was employed in a laboratory in filling tubes with freshly prepared vaccine, a drop of which splashed into her left eye.

Attention is directed to this communication chiefly because to it is appended a bibliography of 38 references arranged in three groups:

(1) Vaccinal keratitis, (2) Vaccinal blepharitis and conjunctivitis, and (3) Pathogenesis of ocular vaccinia.

To any one in search of the literature of the subject this list will be very helpful.

J. B. LAWFORD.

II.—TRACHOMA

(1) **Olitsky, K. (Rockefeller Institute, New York).—Relation of Bacterium granulosis to trachoma.** *Rev. Internat. du Trach.*, October, 1930.

(1) In 1927 Noguchi described the Bacterium granulosis as the cause of trachoma. This was isolated from cases of trachoma among the North American Indians. After the lamented death of Noguchi his work has been continued by **Olitsky**. It was found possible to inoculate monkeys with human trachomatous tissue as well as with cultures of the Bacterium granulosis. The lesions produced resembled those of Indian trachoma, except that the cornea never showed pannus or corneal trachoma. From the infected animals the organism was again isolated, which again was capable of producing trachoma.

The histological changes of the experimentally induced conjunctival lesions correspond closely with those of human trachoma and include the characteristic follicle and scar tissue formation. The histological appearances which are observed in the excised tarsal tissues from cases of trachoma occurring among the American Indians agree with those described as present in similar materials from recognized sources elsewhere. The statements contained in the last two sentences have been questioned by Mayou and Rowland Wilson.

The Bacterium granulosis has a superficial resemblance to the Bacillus xerosis and other diphtheroids and requires special media for its cultivation. Under certain conditions it is motile. Noguchi and Olitsky have described it as being Gram-negative; however, Morax maintains that if the classical method of staining is carried out it is Gram-positive.

A. F. MACCALLAN.

(2) **El-Kattan, Dr. M. Azmi (Cairo).—Some observations on trachoma of the cornea.** *Bull. Ophthal. Soc. of Egypt*, 1930.

(2) **El-Kattan** considers that trachomatous pannus starts below Bowman's membrane, and not between that membrane and the corneal epithelium. He is supported by the authority of Morax, who says " Tous nos examens nous ont montré la prédominance des lésions en arrière de la membrane de Bowman, mais la présence fréquente des infiltrations épithéliales." (Le Trachome, Morax et Petit, Paris, 1929.)

El-Kattan quotes Parsons in support of his opinion, but on referring to Parsons' " Pathology of the Eye," page 198, we read " There is strong evidence that in the early stages the vessels are insinuated between the epithelium and Bowman's membrane, leaving the latter intact."

Up to the present time the best authority on the corneal changes which result from trachoma is Herbert. In the *Transactions of the Ophthalmological Society of the United Kingdom*, Vol. XXIV, 1904, page 67, Herbert states " Together with the ciliary injection there is a marginal zone of vascular ingrowth all round the cornea. The closely set vessels are distinctly, and at their terminations separately, raised above the corneal surface, and are therefore superficial to Bowman's membrane, passing inwards from enlarged conjunctival vessels."

Dusseldorp (Trachoma, Buenos-Aires, 1927) states that in pannus tenuis the vascular infiltration is situated between the epithelium and Bowman's membrane, which remains unaltered, while in the more chronic stages of trachoma, with pannus crassus, Bowman's membrane is partially destroyed and the infiltration penetrates between the layers of the cornea.

A. F. MACCALLAN.

(3) **Sedan, Jean (Marseilles)—Corneal phlyctens in trachoma. (De la kératite phlyctenulaire chez les trachomateux.)** *Rev. Internat. du Trach.*, October, 1930.

(3) **Sedan** has had a long and important experience of trachoma at Marseilles. He considers the subject under two headings, phlyctenular disease in the cicatricial stage of trachoma. (Stages III and IV), and in florid trachoma (Stage II*a*.)

Phlyctenules of the centre of the cornea and also of the upper limbus are very rare. He suggests that the reason the upper limbus is practically immune is that it is always vascularized by the extension in this situation of corneal trachoma. This is an important and probable explanation.

Sedan notes the frequency of rhinitis in all cases of phlyctenular

disease. His experience goes to show that ointments containing mercury are ineffective or harmful, while ointments containing copper are of benefit to the patient.

A. F. MACCALLAN.

(4) **Pascheff, Professor (Sofia).—Chronic hyperplasia of the conjunctiva and true trachoma. (Les hyperplasies chroniques de la conjunctive et le vrai trachome).** *Rev. Internat. du Trach.*, October, 1930.

(4) **Pascheff,** who is a voluminous writer on diseases of the conjunctiva, recognizes several conditions which are characterized by hyperplasia of the conjunctiva on microscopical examination. He gives these the names of plasmo-cellular, lympho-cellular, follicular, papillary and hyalinoid. Each of these conditions is divided into several sub-varieties which Pascheff believes himself able to recognize clinically. The sub-variety, which, according to the author, alone is real trachoma, is confluent-folliculomatous follicular hyperplasia.

A. F. MACCALLAN.

(5) **Olitsky, Knutti and Tyler (New York).—The effect of secondary infections on experimental trachoma.** *Jl. of Exper. Med.*, May 1, 1931.

(5) **Olitsky** has been continuing Noguchi's work on the experimental production of trachoma at the Rockefeller Institute for Medical Research. In the present paper, in which he has had the assistance of **Knutti** and **Tyler,** he states that he has been able to bring about a condition in which the clinical appearance of the trachomatized conjunctiva in monkeys can be brought to resemble that of human trachoma, stages II*b* and II*c*. This is of interest since observations on monkeys with lesions enduring for periods up to three years reveal that, usually, the experimentally induced trachoma retains indefinitely its characteristic resemblance to the human stage I of the disease.

The test animals used were nine *Macacus rhesus* monkeys showing lesions resembling stage I or stage II*a* of human trachoma. This was the result in two cases of sub-conjunctival inoculation with human trachomatous tissue, and in the other seven of inoculation with cultures of Bacterium granulosis. In all the disease had been progressing over a period of from two to seven months before secondary organisms were implanted experimentally upon the diseased conjunctivae. In addition five normal monkeys with clear conjunctivae were used as controls for determining the effects of inoculation of the secondary bacteria alone.

The micro-organisms used for secondary inoculation consisted of some of those usually encountered in the cultivation of conjunctival tissue from trachoma or other conjunctival affections of man and monkey. They were a Gram-positive diphtheroid, staphylococcus albus, Bacillus xerosis, a chromogenic and a spore-bearing bacillus, both Gram-negative, and a non-haemolytic streptococcus.

The method of inoculation was by suspending the growths in the condensation water of the tubes: the turbid growths were removed by means of pipettes and pooled. To the mixture an equal volume of 0·9 per cent. salt solution was added. The application of the culture mixtures to the conjunctivae by daily swabbing over long periods yielded no results either in the monkeys with granulosis lesions or in the controls; even the subconjunctival inoculation of 0·2 c.c. of the mixtures failed in most instances to induce infection.

However, when an equal amount of testicular extract was added to suspensions of the organisms and 0·2 c.c. of the mixture was injected subconjunctivally, and the inoculation repeated three or four times at intervals of three or four weeks, infection resulted. Testicular extract had been used for the purpose of enhancing the pathogenic action of bacteria by other bacteriologists.

The clinical effects were that after a somewhat violent oedema of the conjunctiva and eyelids had subsided the conjunctiva was found to be in a condition of trachoma stage II*b* where the typical sago-grain follicles of trachoma are partly masked by a papillary hypertrophy. In some of the cases trachoma stage II*c* resulted with a dark red tumefied velvety appearance of the conjunctiva.

In two of the monkeys changes occurred in the uninoculated eye after a period, indicating a natural extension of the trachomatous process from the experimentally inoculated eye.

Pannus and lid deformities due to scar tissue formation have not as yet been observed.

In control monkeys the injection of the bacterial mixture was followed by an inflammatory reaction which, in time, subsided without permanent changes in the conjunctiva.

Olitsky's reports of his researches have great interest. In order that these researches shall obtain the whole-hearted support of trachomatologists of all nations it is necessary for the authorities of the Rockefeller Institute for Medical Research to arrange for Olitsky to proceed to Egypt and to repeat in the home of trachoma his interesting researches. At the Giza Memorial Ophthalmic Laboratory he would be able to obtain from the Egyptian Government, through the United States Diplomatic Representative, full facilities for repeating his experiments.

A. F. MACCALLAN.

(6) **Vejdovsky (Czecho-Slovakia).—The surgical treatment of pannus by implantation of buccal mucous membrane. (Traitement opératoire du pannus par l'implantation de muqueuse buccale [procédé de Denig]) *Rev. Internat. du Trach.*, April, 1931.**

(6) **Vejdovsky** has had good results in cases of cicatricial trachoma, stage IV, with marked pannus, by carrying out a peritomy of the cornea and implanting between the corneal margin and the retracted conjunctiva a strip of buccal mucous membrane. This is a modification of Denig's operation.

A. F. MACCALLAN

BOOK NOTICE

Stereoskopischer Atlas der äussern Erkrankungen des Auges. By KARL WESSELY (München). A third series of ten stereo-photographs in colour (2½ in. by 2 in. on cards 7 in. by 4 in.) München: J. F. Bergmann. Price, R.M. 12.00.

The first two series of coloured stereo-photographs were reviewed in this Journal last year (Vol. XIV, pp. 138 and 427). This third series of 10 deals with a variety of common conjunctival and corneal conditions, and their representation is by no means highly successful. An exception must, however, be made for the two photographs illustrating epithelioma of the conjunctiva and a fungating choroidal sarcoma. These gross lesions show up very well indeed and are but further illustration that stereo-photography in colour has its widest use in essentially cutaneous lesions rather than in the finer, purely ocular affections.

OBITUARY

NORMAN M. MACLEHOSE, M.B.

WE regret to record the death, at Ayr, on August 30, of Norman M. MacLehose, M.B., after a prolonged illness. MacLehose was a student of the University of Glasgow (his native city) where he graduated in medicine in 1882. He was for a short time in general practice in Kent, but soon decided in favour of special practice. Going abroad he pursued his studies in ophthalmology in Vienna and Berlin, before settling in London. He became a Clinical Assistant at Moorfields Eye Hospital, where he worked in the

clinic of his fellow-countryman, the late John Couper. He was subsequently elected an Assistant Surgeon to the Central London Ophthalmic Hospital, but retained this position for only a few years. He became a member of the Ophthalmological Society of the United Kingdom, in 1889, and, until he gave up his house in town, was a fairly regular attendant at the meetings, which at that time were held once a month. From 1891 to 1899 he was Editor of *The Ophthalmic Review*. Although keenly interested in his subject he made but few contributions to the literature of ophthalmology: he read abundantly and widely, but was not fond of writing. MacLehose married a daughter of Alexander Macmillan, the publisher, and leaves one son and one daughter. His wife died some years ago, and a younger son fell in the war of 1914-1918.

CORRESPONDENCE

THE FITTING OF CONTACT LENSES

To the Editors of THE BRITISH JOURNAL OF OPHTHALMOLOGY.

SIRS.—Probably the major difficulties in the successful fitting of contact lenses are the elimination of air bubbles, and also of being able to stimulate the confidence of the patient by a rapid and simple technique in applying and removing the lenses.

From the available literature of the makers of these lenses, no guidance is given on the methods of fitting and therefore, as a result of many practical tests, the following observations are submitted in the hope that they may prove helpful, it having been discovered that by employing this technique, the fitting is simplified whilst eliminating the difficulty of the air bubbles.

In applying the rubber sucker to the contact lens prior to fitting, *only a small portion* of the air should be excluded, retaining just sufficient suction to hold the lens in position. It will be realized that when the lens is *in situ*, the easy removal of the sucker is of vital importance. The patient's head should naturally be held in a horizontal position over a towel or other soft material. Both eyelids should be well open and the lens inserted under the lower lid first, with the upper lid well extended clear of the contact lens. The patient is then asked to look directly downwards, and at the same time the lens is gently pressed on to the eye.

It is of the greatest importance that the lens should be applied to the eye very gently; only just sufficient suction is necessary to

retain the lens in position without slipping. Too much pressure causes suction in the centre space of the contact lens over the pupil because of the tendency to create a vacuum, and causes discomfort. Both eyelids should then be released and allowed to traverse the contact lens before any attempt is made to remove the sucker, and then by firmly excluding all air from the sucker it will fall away very readily. In this way the contact lens is retained in position by just the right amount of contact suction and is correspondingly easy of removal.

To remove the lens from the eye *all the air* should be excluded from the sucker before applying, the end of the sucker being moistened with water. It should then be firmly pressed on to the contact lens. The sucker now has a firm grip of the lens, and it is possible by a downward leverage to transmit a pressure on to the lower rim of the contact lens which will cause it to admit air at its top edge and come easily away from the eye with a minimum of discomfort to the patient. It is not necessary by this method to use a probe or other instrument for the admission of air or leverage of the lens from the sclera.

Yours truly,

GEORGE PAXTON.

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NOTES

Death

AS we go to press we learn, with much regret, of the death of Professor K. K. K. Lundsgaard, of Copenhagen.

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Addendum to Turberville of Salisbury

IN an account of Turberville of Salisbury in Vol. X, p. 465, it was stated that after his death, his sister, Mary Turberville, carried on his practice in London. Through the courtesy of Dr. George Peachey we are enabled to give a copy of her advertisement in the Press. It occurs in the *London Gazette*, June 5, 1701, and runs as follows: "Mrs. Mary Turbervile, sister to the late Dr. Turbervile of Salisbury, liveth in Little Lincoln's Inn, near the Grange Inn, and practises on diseases curable of the eye."

In the issue of June 9, of the same journal, is the advertisement of "Mons. Girard, oculist, who may be heard of at Mons. Buissière, surgeon, at the Blue Balcony in Suffolk Street, Pall Mall." Details

of the career of Paul Buissière, surgeon, will be found in Peachey's Memoir of William and John Hunter, p. 9.

That it was not unusual for an ophthalmic practice to be undertaken by some relative after the death of the founder is proved by the fact that Augustina, Lady Read, carried on the practice of the notorious quack, Sir William Read, in Durham Yard, Strand, after Read's death.

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A Roman Oculist's Stamp

IN the *Daily Telegraph* for July 31, 1931, is an account of another of these interesting fragments of antiquity found recently near London Bridge, at a depth of 15 feet below the surface. The stamp is of the usual size, the oculist's name was Caius Silvius Tetricus and three of his formulae run according to the common form of such things. The inscription on the fourth side is indecipherable. In the same issue is noted the fact that in 1929 a small pot of red Samian ware was discovered in Moorgate marked with the words, "Lucius Julius Senlis's saffron salve for roughness of the eyelids." Moorgate would seem an appropriate setting for such a find.

FUTURE ARRANGEMENTS

1931

October 6.—Midland Ophthalmological Society, at Birmingham.

October 16.—North of England Ophthalmological Society, at Manchester.

November 6.—North of England Ophthalmological Society, at Bradford.

December 1.—Midland Ophthalmological Society, at Birmingham.

December 4.—North of England Ophthalmological Society, at Leeds.

1932

February 5.—North of England Ophthalmological Society, at Newcastle-on-Tyne.

March 4.—North of England Ophthalmological Society, at Liverpool.

April 8.—North of England Ophthalmological Society, at Sheffield.

CONTEMPORARY OPHTHALMIC LITERATURE

American Journal of Ophthalmology. *August, 1931.*

JACKSON. The control of myopia.
MACHT. Some interesting experiences in the clinical pharmacology of the eye.
SUKER. The filtration operation of Mauksch for chronic glaucoma with preliminary report on twenty-four operations.
HOWARD. Divergence paralysis.
LEARMONTH, LILLIE and KERNOHAN. Unusual surgical lesions affecting the optic nerves and chiasm.
MOORE. Fragment of copper wire in the vitreous.
POST. Diversified thermophore therapy.
CASTROVIEJO, SR., and CASTROVIEJO, JR. Epibulbar nevo-carcinoma with almost total corneal involvement.
WOLFE. Iridencleisis for glaucoma with aphakia
EVANS. The clinical value of angioscotometry.
KRAVITZ. The value of quadrant field defects in the localization of temporal lobe tumors.
KING, JR. Pulsating exophthalmos.
SHUMWAY. Spontaneous cyst of the iris.
PFAHLER and SPACKMAN. Roentgen therapy in pituitary tumors.
SMUKLER. Stretching the opponent muscle as part of routine treatment of convergent squint due to errors of refraction.

Archives of Ophthalmology. *August, 1931.*

HOLTH. Histology of fistulas following anterior sclerectomy.
DUKE-ELDER. The metabolism of the eye. II. Clinical observations.
DAVIS. Chiasmal symptoms in intracranial tumors.
PARKER and FRALICK Choroideremia: report of a case.
GOALWIN. Contribution to the art of localising ocular foreign bodies.
ABBOTT. Ocular symptoms in the diagnosis of tumor of the brain.
BEIGELMAN. Unilateral pigmentary retinitis.

Annales d'Oculistique. *July, 1931.*

BAILLIART. Some considerations of the pressure in the central vein of the retina.
TERSON. Advantages of and indications for the use of 1 per cent. silver nitrate ointment.
AUERBACH. Ophthalmological contribution to the study of sterilization of the female.
LACARRÈRE. Congenital ocular torticollis.
SÉDAN. Bilateral cataract following thyroidectomy in exophthalmic goitre.
FILATOFF. Should one remove tumours extending beyond the limits of the orbit?
MORAX. Concerning the article by Dr. Bourguet on cysts of the pouch of Rathke.

Archives d'Ophtalmologie. *August, 1931.*

MARTEL, MONBRUN and GUILLAUME. The ophthalmological future of patients operated on for tumours of the hypophysis.
CUÉNOD and NATAF. Biomicroscopy in a case of tuberculous conjunctivitis.
FRANCOIS. The haematology of trachoma.
NORDMANN. The sensitivity of the lens to X-rays.
PAVIA. The alterations of the retinal reflexes.
KELLER. Note on the working of the ophthalmological institute of Hanoï.

Revue d'Oto-Neuro-Ophtalmologie. *July, 1931.*

HÖGYES. The nervous mechanism of associated movements of the eyes.
CARLOTTI and JACQUET. Retinal arterial tension in certain cerebral syndromes.
AUBARET. Inferior hemianopia from embolism and retinal angiospasm.

Société d'Ophtalmologie de Paris. *June, 1931.*

BAILLIART, MONTAIS and SCHIFF-WERTHEIMER. Intracranial aneurysm involving the five last cranial nerves on the right side.

MARGERIN and PLICQUE. Blepharochalasis.

ROCHON-DUVIGNEAUD, VEIL and CHAFIR. The chiasmal syndrome. Radiotherapy. Aggravation. Treatment by surgical removal of tumour.

JEAN-GALLOIS. Spasm of the retinal artery in an asthmatic previously treated by large injections of adrenalin. Treatment by acetylcholine.

DUPUY-DUTEMPS. Papillary ethmoido-maxillary epithelioma. Cure with loss of the eye by radiotherapy after failure of surgical treatment.

WORMS. Spastic visual disturbances in aviators.

——— Bilateral absence of abduction with retraction of the globe of congenital origin.

TERSON. Sutures of mucous membrane in dacryostomy and two instruments which illustrate this.

BOURGUET. Clinico-pathological and therapeutic remarks on the observation of Mme. Schiff. "Spontaneous evacuation by the nasal route of a cyst of the pouch of Rathke."

PAVIA. A case of coloboma of the lens and other ocular malformations.

——— Arganaraz' method for fistulisation in the treatment of chronic dacryocystitis.

POLACK. Test of colour vision.

MONTHUS and ROCHON-DUVIGNEAUD. Vitreous exudates in glaucoma.

KALT. Abnormal glands associated with the lacrimal sac.

Klinische Monatsblätter für Augenheilkunde. *August, 1931.*

WEVE. The substitution method for localisation of retinal tears.

ASCHER. On the mechanism of the reduction of intra-ocular tension by Erythrophline.

WERKLE. Observations on our knowledge of the clinical picture of progressive choroidal atrophy with pigmentary degeneration of the retina.

MÜLLER. Congenital entropion with epiblepharon.

VOM HOFE. On the influence of cauterisation on regeneration.

PIECK. A remarkable regeneration of the cornea after perforating injury.

BÖMER. On a case of lining of both lacrimal sacs with stratified epithelium.

SCHMELZER. A simple method of investigation of the hemianopic pupil reaction by means of the slit-lamp.

JUHÁSZ-SCHÄFFER. Work on vitamin E.

LITINSKY. A bilateral round symmetrical appearance in the vitreous.

BLATT. Chloroma of the orbit.

SAMOJLOFF. Experimental and clinical details of the tuberculin reaction in tuberculous keratitis.

PETROVIĆ and TSCHEMOLOSSOW. On the question of voluntary dilatation of the pupil.

HANDMANN. On the transitory fluorescein-positive corneal line in youth.

Zeitschrift für Augenheilkunde. *August, 1931.*

ELSCHNIG. Intracapsular extraction of senile cataract.

JUNIUS. Short notice on the work of Prof. Peters-Rostock "The knowledge of trachoma then and now."

BARTELS. The influence of repeated operations for the relief of tension in congenital hydrophthalmos and the appearance of high myopia on the same side.

——— Habitual and spontaneous dislocation of the lens.

——— Are there special pupillary fibres for the indirect reaction?

BORMACHER. On radiography of the optic foramen.

KRASSO. Clinical and histological observations on our knowledge of the deep effects of Bucky's rays on the eye.

HEGNER. A successful cataract extraction by a blow from a cow's horn.

JAENSCH. Bilateral trochlearis paresis as the sole disturbance of motility in a tumour of the thyroid.

HAAS. An attempt at the quantitative estimation of the light sense.

PASCAL. Skiascopy with the photoscope.

FALTA. Remarks on the work of Prof. Birch-Hirschfeld "A comparison of the results of senile cataract extractions."

Annali di Ottalmologia e Clinica Oculistica. *May, 1931.*

MARGOTTA. Melanosarcoma of the choroid in an atrophic ossified eye.
SCOTTI. Contribution to our knowledge of tuberculous episcleritis.
CORRADO. Clinico-histological observations on inclusion cysts of the conjunctiva.
D'AMICO. Contribution to the study of keratoconus.
BAQUIS. Apparent neutralisation of the diplopia in excessive convergence and the inherent error in the judgment of size.

Archivio di Ottalmologia. *May-June, 1931.*

TIRELLI. On a case of occlusion of the central artery of the retina.
——— Pneumococcal conjunctivitis with ulceration of the conjunctiva.
SANNA. The behaviour of visual acuity in regular astigmatism.
MORETTI. Heredity and senile cataract.
GENNARO. Tutocaine in tonometry.
SALVATI. Optic neuromyelitis.
MAZZI. Proliferating retinitis of Manz from recurrent haemorrhage of the retina, in a tuberculous patient.
BARDANZELLU and VALLEBONA. On a case of uniocular pulsating exophthalmos.
ROSSI. Heterochromia of the iris and tuberculous affections *(cont.)*.

Lettura Oftalmologica. *May, 1931.*

DE PETRI. Contribution to the discussion of ocular lesions in vaccinia.
MONTANELLI. Ocular myasis.

June, 1931.

CASO. Myopia and tension in connection with ocular lesions.
NEUSCHÜLER. Relapsing ulcerative pannus connected with menstruation.
KOCH. Ocular lesion from an agricultural accident. Penetration of the sclera by a thorn.

Revista Oto-Neuro-Oftalmologica. *May-June, 1931.*

FERRERI GIO. On the arterial circulation of the upper jaw and the antrum of Highmore in the adult.
VANCEA. Congenital orbital cyst of ethmoidal origin.
MARSIGLI. Multiple post-diphtheritic paralysis of cranial nerves.

Archivos de Oftalmologia Hispano-Americanos.

August, 1931.

BARRIÈRE. On the disease of Lindau, von Hippel, and Coats.
LUQUE. Retinal arterial hypertension in generalised hyperpiesis.

Boletin de Informacion Oftalmologica. *May-June, 1931.*

LANDO. The tuberculous aetiology of scleritis.
BARRIOS and NOCITO. Ocular anaphylaxis from hydatid cyst of the orbit.
IRIBARREN and URQUIJO. Malpighian epithelioma of the corneo-scleral junction.
DAMEL. Reconstruction of the conjunctival sac after enucleation.

Revista Oto-Neuro-Oftalmologica y de Cirugia Neurologica.

DUSSELDORP. Ocular symptoms of myasthenia gravis pseudo-paralytica of Erb-Goldflam.
QUESADA. Interpretation of the clinical value of the symptom of vertigo.